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Preclosure Radiological Calculations to Support Salt Site Evaluations

Technical Report

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ABSTRACT

The purpose of this report is to provide data, methods, and results of preclosure radiological calculations to support salt site evaluations on the basis of the U.S. Department of Energy's Siting Guidelines. The data and methods portions are of sufficient detail to enable independent analyses of the conditions specified. The results are presented for easy comparison with pertinent radiological regulations.

The regulations applicable to this discussion are found in 10 CFR Part 60, which defers to 10 CFR Part 20, and in 40 CFR Part 191, which defers to 40 CFR Part 190. These regulations cover both offsite radionuclide concentrations and doses. The comparisons required by the DOE guidelines include 10 CFR Part 20 concentrations and 40 CFR Part 191 (maximum exposed individual) doses. To lend further insight into the radiological impacts of the presence of a high-level nuclear waste repository at a specific location, the population doses associated with the 40 CFR Part 190 analyses and accident doses also have been included.

All concentrations and doses are found to be well below applicable standards.

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1 INTRODUCTION

The purpose of this report is to provide data, methods, and results of preclosure radiological calculations to support salt site evaluations. The data and methods portion should be of sufficient detail to enable an independent analysis of the conditions specified. The results portion should be of sufficient clarity and appropriateness to enable a judgment to be easily made concerning a repository's compliance or noncompliance with radiological regulations. The scope of regulations necessarily addressed includes any that pertain to radiological materials in the environment during the preclosure phase, whether promulgated by the U.S. Environmental Protection Agency (EPA) or by the U.S. Nuclear Regulatory Commission (NRC). Some results that are not addressed explicitly in the existing regulations but which provide additional insight into the radiological impacts of a repository in the preclosure phase are also included. Examples of these are population doses and doses from accidental releases.

These assessments have been made to contribute to the data available for nominating three salt sites from the set of seven as defined in the "Nuclear Waste Policy Act of 1982" and the DOE Guidelines, which are under concurrent development (see Appendix A).

2 ADHERENCE TO REGULATIONS

Section 960.5-1(a)(1) of U.S. Department of Energy's (DOE) draft "General Guidelines for Recommendation of Sites for Nuclear Waste Repositories"[1] addresses the preclosure radiological safety aspects of systems guidelines. Here it is stated: "Any projected radiological exposures of the general public and any projected releases of radioactive materials to restricted and unrestricted areas during repository operation and closure shall meet the applicable safety requirements set forth in 10 CFR Part 20[2], 10 CFR Part 60[3], and 40 CFR Part 191[4], Subpart A (see Appendix B of this Part)."

The phases of the repository specifically addressed here are construction and operation. The closure phase, the analysis of which is also required by the Guidelines, is not addressed explicitly because documentation of all previous decommissioning studies indicates that the radioactive emissions during decommissioning can be controlled to levels far below those during the operational period[5]. For instance, it has been estimated[6] that during the complete dismantling of a 1,175 MW(e) pressurized water reactor (PWR), only 85 μCi of radioactive materials would be released to the environment. Examination of limited decontamination activities in a repository indicates that this situation will also be the case with the decommissioning of a repository.

2.1 10 CFR ANALYSIS

Dealing first with the U.S. Nuclear Regulatory Commission (NRC) portion of these requirements, 10 CFR Part 60[3] sets no new radiological limits, but rather references 10 CFR Part 20[2]. Part 60 states, "The geologic repository operations area shall be designed so that until permanent closure has been completed, radiation exposures and radiation levels, and releases of radioactive materials to unrestricted areas, will at all times be maintained within the limits specified in Part 20 of this chapter...."[3]

Sections 20.105 and 20.106 of 10 CFR Part 20 contain NRC's numerical limits for radiation and radioactivity in unrestricted areas. The former, entitled "Permissible Levels of Radiation in Unrestricted Areas", states "There may be included in any application for a license or for amendment of a

license proposed limits upon levels of radiation in unrestricted areas resulting from the applicant's possession or use of radioactive material and other sources of radiation. Such applications should include information as to anticipated average radiation levels and anticipated occupancy times for each unrestricted area involved. The Commission will approve the proposed limits if the applicant demonstrates that the proposed limits are not likely to cause any individual to receive a dose to the whole body in any period of one calendar year in excess of 0.5 rem."

Section 20.106, entitled "Radioactivity in Effluents to Unrestricted Areas", states "A licensee shall not possess, use, or transfer licensed material so as to release to an unrestricted area radioactive material in concentrations which exceed the limits specified in Appendix B, Table II of this part, except as authorized pursuant to § 20.302 or paragraph (b) of this section. For purposes of this section, concentrations may be averaged over a period not greater than one year." The numerical limits included in this table are for maximum permissible concentrations (MPC) and are listed for the specific nuclides of interest later in this section where the analyses are discussed.

Since external radiation fields emanating from the repository facilities are expected to be infinitesimal in unrestricted areas, the analysis of compliance with provisions of 10 CFR Part 20 entails only the radionuclide concentrations released during facility operations compared to the appropriate concentration limits. Two options are given in Section 20.106 (d) for calculating the facility-contributed concentrations to be compared with the concentration limits. This section states, "For the purposes of this section the concentration limits in Appendix B, Table II of this part shall apply at the boundary of the restricted area. The concentration of radioactive material discharged through a stack, pipe or similar conduit may be determined with respect to the point where the material leaves the conduit. If the conduit discharges within the restricted area, the concentration at the boundary may be determined by applying appropriate factors for dilution, dispersion, or decay between the point of discharge and the boundary." No credit for atmospheric dispersion is necessary to demonstrate compliance here.

The concentrations at the top of the stack are calculated by dividing the anticipated radionuclide release rates by the volume of air being released

from the stack per unit of time. Calculating the concentrations at a point in the environment, be it the site boundary or some other point, as will be necessary in the subsequently discussed 40 CFR Part 191 calculations, involves the use of the site-specific dilution and dispersion factors referred to in 10 CFR 20.106(d), as well as the anticipated radionuclide release rates (source term) from the repository.

The calculation of radionuclide concentrations at the top of the stack involves no site-specific data, but rather only generic facility characteristics, assumed to be the same for all sites. The calculations presented here assume that, for the operational phase of the repository, a small percentage of the received spent fuel elements have been damaged during transportation and that perhaps some of the drummed wastes will arrive in leaky condition. (See Appendix B.) These conditions are reflected in the operational source term. Credit is taken for the fact that all gases released from surface facilities will vent through high-efficiency particulate and charcoal filters, trapping essentially all of the released particulates and 99 percent of the released iodine. (See Appendix B.)

The radionuclides anticipated to be released during construction, before waste arrives, and during operation are shown in Tables 2-1 and 2-2, respectively. (See Appendix B.) All radionuclides released during construction consist of naturally occurring radon and its decay products.

Table 2-1. Construction Radionuclide Emissions

Radionuclide	Total Release, Ci	Release Rate, Ci/Sec
Rn-220	7.4×10^{-3}	2.9×10^{-11}
Rn-222	1.0×10^{-2}	4.0×10^{-11}
Pb-210	8.8×10^{-7}	3.5×10^{-15}
Pb-212	1.1×10^{-5}	4.4×10^{-14}
Pb-214	1.0×10^{-2}	4.0×10^{-11}
Bi-210	1.0×10^{-2}	4.0×10^{-11}

DOE/ET-0028[7], Figure 7.4.18, shows a mining period of 8 years. Thus, the total emissions from mining 35 million metric tons of salt over the 8-year period are as shown in Table 2-1.

These emission estimates could be revised to correspond to the currently planned excavation amounts, but given that current estimates for mined salt are not significantly different (24 to 27 MMT), that the emission estimates are coarse, and that the impacts of the revisions would be insignificant, the values in Table 2-1 are proposed as upper limits.

It can be assumed that the emission rate of construction-related radionuclides will continue relatively unchanged during the operational period. Therefore if only spent fuel is being handled, the total operational release is the sum of the "construction" and "operation" source terms. If only high-level waste is being handled, then the total "operational" release is that represented by the "construction" sources terms.

Table 2-2. Operational Radionuclide Emissions

Radionuclide	Annual Release, Ci	Release Rate, Ci/Sec
H-3	3.0×10^{-2}	9.5×10^{-10}
C-14	2.4×10^{-4}	7.6×10^{-12}
Kr-85	$1.8 \times 10^{+1}$	5.7×10^{-7}
I-129	3.0×10^{-5}	9.5×10^{-13}

Operational releases as those shown in Table 2-2 can arise because of the possibility of pin rupture in the transportation cask. In the reference the releases from each failed fuel pin are assumed to occur over a 2-day period.[8] However, for release of this type and frequency, 10 CFR 20.106(a) permits averaging over a year.[2] However, it is difficult to analyze pin failure because there have been no observed transportation-related ruptures.

In statistics collected at Savannah River Plant (and presented in DOE/ET-0054[8], page v-16), it was stated that 1,200 casks containing 25

assemblies each were transported without pin failures. From this it can be shown with 95 percent confidence that the probability of at least one pin failure in an assembly is less than 0.01 percent. The report then deduced that the probability of a pin failure was no greater than 0.01 percent per pin shipped.

The number of pins shipped, although unreported, had to be at least 1.92 million (on an 8 x 8 array) and could have been 8.67 million (on a 17 x 17 array). Using the lower number, one can state with 95 percent confidence that the pin failure rate is less than 2 per million.

The DOE/NE-0017/2[a] reports that there will be as many as 582,684 (2,016 shipments/year times 17 x 17) pressurized water reactor (PWR) pins shipped per year. In addition, there will be boiling water reactor (BWR) pins equivalent in mass to 61 percent (570 metric tons uranium [MTU]/930 MTU) of the PWR pins. Therefore, there may be as many as 940,000 pins shipped per year (approximately 1 million).

If the pin failure rate is 2 per million, and 1 million pins per year are shipped, then using Poisson statistics one can expect that there is more than 99 percent probability of no more than six failures in a year.

The generic engineering descriptions used for this analysis indicate that the construction-related radionuclides will be diluted in 964,000 cubic feet per minute (4.55×10^8 cubic centimeters per second) and operation-related radionuclides in 298,000 cubic feet per minute (1.41×10^8 cubic centimeters per second).[10]

The phenomenon being characterized in these calculations is the dilution of the radionuclides being released in the ventilation exhaust air being expelled from the top of the stack during the construction and operational phases of the repository. Dividing the release rates of Rn-220, Rn-222, Pb-210, Pb-212, Pb-214, and Bi-210 in μCi per second by the construction phase ventilation exhaust rate in cubic centimeters per second yields the concentration of each radionuclide at the top of the stack. Likewise, dividing the release rates of H-3, C-14, Kr-85, and I-129 by the exhaust rate value yields the appropriate concentrations for comparison with the 10 CFR limits. These concentrations are given in Table 2-3. Also given for comparison are the 10 CFR Part 20 Appendix B, Table II permissible concentration limits.

Table 2-3. 10 CFR Part 20 Comparison at Top of Stack

	Emission Rate, µCi/sec	Conc µCi/cm^3	MPC µCi/cm^3	Conc/MPC
		Construction		
Rn-220	2.9×10^{-5}	6.4×10^{-14}	1×10^{-8}	6×10^{-6}
Rn-222	4.0×10^{-5}	8.8×10^{-14}	3×10^{-9}	3×10^{-5}
Pb-210	3.5×10^{-9}	7.7×10^{-18}	4×10^{-12}	2×10^{-6}
Pb-212	4.4×10^{-8}	9.7×10^{-17}	6×10^{-10}	2×10^{-7}
Pb-214	4.0×10^{-5}	8.8×10^{-14}	2×10^{-8}	4×10^{-6}
Bi-210	4.0×10^{-5}	8.8×10^{-14}	2×10^{-10}	4×10^{-4}
			Total	4×10^{-4}
		Operation		
H-3	9.5×10^{-4}	6.7×10^{-12}	2×10^{-7}	3×10^{-5}
C-14	7.6×10^{-6}	5.4×10^{-14}	1×10^{-7}	5×10^{-7}
Kr-85	5.7×10^{-1}	4.0×10^{-9}	3×10^{-7}	1×10^{-2}
I-129	9.5×10^{-7}	6.7×10^{-15}	2×10^{-11}	3×10^{-4}
			Total	1×10^{-2}

Where multiple radionuclides are involved in an effluent stream, compliance of that waste stream is determined by comparing with unity the summation of the concentration of each nuclide divided by its MPC, over all radionuclides. That is $\sum_i \frac{conc_i}{MPC_i} \leq 1.$(2) The results of these calculations are also shown in Table 2-3 for construction and operational repository phases.

Table 2-3 shows that all radionuclide releases even at the top of the stack are orders of magnitude below their respective MPC limits, with the exception of Kr-85 which is 1/100 of its MPC. The sums over all radionuclides released show compliance with 10 CFR limits with sizable margins of safety.

2.2 40 CFR

The second part of the DOE guideline deals with U.S. Environmental Protection Agency (EPA) 40 CFR requirements. Part 191(4) sets no new radiological limits, but rather references 40 CFR Part 190(11).

2.2.1 40 CFR Introduction

The Federal Register entry that discussed this proposed rule states:

"The provisions of Part 191 require the combined impacts from multiple operations to meet a single set of dose limitations which will be the same in both Parts 190 and 191. Section 191.03 therefore requires that the combined annual dose equivalent to any member of the public due to operations covered by Part 190, and to direct radiation and planned discharges of radioactive materials covered by this Subpart, shall not exceed 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ. It also requires that waste management operations be conducted so as to reduce exposures for members of the public below this level to the extent reasonably achievable, taking into account technical, social, and economic considerations."

Demonstrating compliance with these dose limits entails calculating the doses from all potential exposure mechanisms to an individual at each site who receives maximum exposure. Such exposure would come from radionuclides released through the plume of the stack to the atmosphere during the construction and operation of a repository. Human exposure would occur through

submersion in and inhalation of radionuclides in the plume and through invasion of the food chain by radionuclides. The methods by which each of these dose components were calculated will be discussed before the results are presented. Since these calculations are for the routine emissions during the construction and operation of a repository, the applicable source terms and facility characteristics are those assumed in the 10 CFR Part 20 analysis. Meteorological data for the sites are given in References 12 and 13. It is also important to note that the durations of the construction and operational phases have been assumed to be 8 and 26 years, respectively.

2.2.2 40 CFR Analysis

All of the 40 CFR Part 191 analyses are based upon initial atmospheric transport and dispersion of the released radionuclides. The dispersion calculations are based on site geometries[14], meteorological characteristics of the sites, and atmospheric dispersion models that have been developed over the years.[15] Shown in Table 2-4 are the stability class frequency distributions for the Gulf Coast Salt Dome and Palo Duro Basin sites. Anticipating that micrometeorological characteristics of the Paradox Basin site will be important and that the regional nature of the Paradox environmental characterization report does not adequately reflect these characteristics, the stability for the Paradox was conservatively classified as F.

Given the appropriate stability class, the annual average wind speeds, which are shown in Table 2-5, and the height of the release point (ground level by U.S. Nuclear Regulatory Commission definition), the computer code DACRIN[15] calculates, using the following equation

$$X = \frac{Q}{\pi \bar{u} \sigma_y \sigma_z}$$

where

$\bar{u}$ = annual average wind speed (m/sec)
σ_y = horizontal dispersion coefficient (m)
σ_z = vertical dispersion coefficient (m)
π = 3.1416

Table 2-4. Atmospheric Stability Class Frequency Distributions

Stability Class	Frequency [%]	
	Palo Duro	Gulf Domes
A	0.4	0.7
B	4.2	5.1
C	10.7	10.3
D	58.6	47.2
E	14.7	36.7
F	11.0	

Table 2-5. Calculated X/Q Values for Normal Conditions

Distance (m)	Palo Duro X/Q	Paradox X/Q	Mississippi Gulf X/Q (sec/m^3)	Louisiana Gulf X/Q
72,400	4.56×10^{-8}	2.41×10^{-6}	9.12×10^{-8}	6.85×10^{-8}
56,300	6.37×10^{-8}	3.11×10^{-6}	1.27×10^{-7}	9.56×10^{-8}
40,200	9.57×10^{-8}	4.23×10^{-6}	1.91×10^{-7}	1.44×10^{-7}
24,100	1.63×10^{-7}	6.31×10^{-6}	3.26×10^{-7}	2.45×10^{-7}
12,100	2.81×10^{-7}	9.47×10^{-6}	5.62×10^{-7}	4.22×10^{-7}
4,020	4.71×10^{-7}	1.38×10^{-5}	9.42×10^{-7}	7.07×10^{-7}
240	2.79×10^{-4}	9.95×10^{-3}	5.58×10^{-4}	4.19×10^{-4}
Stability Class	D	F	D	D
Mean wind speed m/sec	6	1	3	4

the ground-level concentration of each nuclide (X) in terms of Ci/m^3 per unit release rate for that radionuclide in terms of Ci/sec(Q). This calculation is repeated for each source/receptor distance of interest.

As site-specific meteorological data become available, X/Q values will be calculated for each distance of interest and compass sector to more accurately characterize atmospheric dispersion. The results of the simpler calculations are shown in Table 2-5.

The environmental transport of these atmospherically dispersed radionuclides into human food chains was evaluated using the computer code PABLM.(16) PABLM estimates human doses resulting from external radiation exposure and ingestion of radionuclides transported through aquatic and terrestrial pathways in the biosphere. The code includes a large number of biosphere pathway submodels in order to be able to evaluate the transport through all the important pathways that may be possible. For example, the radiation dose models include exposure to radionuclides deposited on the ground or crops from contaminated air, radionuclides on the ground or crops from contaminated irrigation water, radionuclides in contaminated drinking water, radionuclides in aquatic foods, and radionuclides in bodies of water and sediments where people might fish, boat, or swim. For crop contamination, the dose models consider both direct deposition on leaves and uptake through roots. The code is capable of handling a total of 19 ingestion pathways with corresponding consumption rates, growing periods, air and water concentrations, and deposition rates. A total of four external exposure pathways are possible in the code with corresponding exposure time and soil and water concentrations.

Radioactive decay is explicitly taken into account during the biosphere transport processes, including storage of food after harvest. The code automatically evaluates daughter products resulting from radioactive chain decay. The doses generated in these calculations are the dose commitments resulting from chronic exposure for a specific period of time or from acute exposures within a limited time frame. For ingestion pathways, the types and amounts of crops grown and animal products consumed determine the terrestrial pathways evaluated. These specific inputs for average individuals in the Palo Duro, Paradox, and Gulf Coast Salt Dome Basins are shown in Tables 2-6 to 2-8. (17,18,19)

Contamination of farmland or garden plots may result from airborne or waterborne radionuclide releases, or may be residual environmental

Table 2-6. Palo Duro Pathway Input Data

Variable Description	Numerical Value	Growing Period, d	Yield, kg/m^2	Storage Time, d	Consumption Rate, kg/y	Reference (ONWI Report No.)
Population (permanent + transient)	305,000					p. 5(102)[19]
ft^3/sec in which release is diluted	150					p. 183(102)
Terrestrial pathway parameters						
Leafy vegetables		90	1.5	14	15	p. 83(102);(446) PABLM[18]
Other aboveground vegetables		60	0.7	14	15	p. 83(102),PABLM
Potatoes		90	4.0	14	117	p. 83(102),PABLM
Other root vegetables		90	4.0	14	117	p. 83(102),PABLM
Berries	N	-	-	-	-	-
Melons		90	2.0	14	15	p. 83(102),PABLM
Orchard fruit	N	-	-	-	-	-
Wheat		90	1.0	14	80	p. 82(102),PABLM
Other grains		90	1.0	14	80	p. 82(102),PABLM
Eggs	N	-	-	-	-	-
Milk	N	-	-	-	-	-
Beef		90	0.84	34	40	p. 84(102),PABLM
Pork		90	0.84	34	40	p. 84(102),PABLM
Poultry		90	0.84	14	40	p. 148(102),PABLM
Field deposition, ext. exposure (hr/y)	2,920					p. 84(102),PABLM
Irrigation rate (1/m^2/mo)	150					PABLM App G
Aquatic pathway parameters						
Fish				1.0	40	p. 161(102),PABLM
Crustacea	N	-	-	-	-	-
Molluscs	N	-	-	-	-	-
Water plants	N	-	-	-	-	-
Drinking water				1.0	730	p. 161(102),PABLM
Shoreline - external exposure				0.33	500	p. 166(102),PABLM
Swimming - external exposure				0.33	100	p. 166(102),PABLM
Boating - external exposure				0.33	100	p. 166(102),PABLM
Shore width	0.2					p. 166(102),PABLM

Table 2-7. Paradox Pathway Input Data

Variable Description	Numerical Value	Growing Period, d	Yield, kg/m^2	Storage Time, d	Consumption Rate, kg/y	Reference (ONWI Report No.)
Population (permanent and transient)	32,000					p. 172(144)[20]
ft^3/sec in which release is diluted	25					p. 55(144)
Terrestrial pathway parameters						
Leafy vegetables	NA*					
Other aboveground vegetables	NA					
Potatoes	NA					
Other root vegetables	NA					
Berries	NA					
Melons	NA					
Orchard fruit	NA					
Wheat		90	0.22	14	80	p. 148(144), PABLM App[18]
Other grains		90	1.0	14	80	p. 135(144), PABLM App G
Eggs	NA					
Milk	NA					
Beef		90	0.84	34	40	p. 133(144), PABLM App
Pork	NA					
Poultry	NA					
Field deposition, ext. exposure (hr/y)	2,920					p. 148(144) p. 67(144)
Irrigation rate ($l/m^2/mo$)	2,500					p. 58(144) p. 71(144)

*Not applicable to this site.

Table 2-7. (Continued)

Variable Description	Numerical Value	Growing Period, d	Yield, kg/m^2	Storage Time, d	Consumption Rate, kg/y	Reference (ONWI Report No.)
Aquatic pathway parameters						
Fish				1.0	40	p. 122(144), PABLM App
Crustacea	NA*					
Molluscs	NA					
Water plants	NA					
Drinking water				1.0	730	PABLM, App G
Shoreline - external exposure				0.33	500	PABLM, App G
Swimming - external exposure				0.33	100	PABLM, App G
Boating - external exposure				0.33	100	PABLM, App G
Shore width	0.2					

*Not applicable to this site.

Table 2-8. Gulf Coast Domes Pathway Input Data

Variable Description	Numerical Value	Growing Period, d	Yield, kg/m^2	Storage Time, d	Consumption Rate, kg/y	Reference (ONWI Report No.)
Population (permanent and transient)	306,000					p. 135(193)[21]
ft^3/sec in which release is diluted	60,000					p. 56(193)
Terrestrial pathway parameters						
Leafy vegetables	N	-	-	-	-	
Other aboveground vegetables	N	-	-	-	-	
Potatoes	Y	90	4.0	14	117	p. 114(193), PABLM App[18]
Other root vegetables	Y	90	4.0	14	117	p. 114(193), PABLM App
Berries	Y	90	2.0	14	64	p. 114(193), PABLM App
Melons	N	-	-	-	-	
Orchard fruit	Y	90	2.0	14	64	p. 114(193), PABLM App
Wheat	Y	90	1.0	14	80	p. 115(193), PABLM App
Other grains	Y	90	1.0	14	80	p. 115(193), PABLM App
Eggs	Y	90	0.84	18	20	p. 117(193), PABLM App
Milk	Y	30	1.3	4	230	p. 119(193), PABLM App
Beef	Y	90	0.84	34	40	p. 119(193), PABLM App

contamination from a previous release. For sites where irrigation is used, sprinkler irrigation is normally assumed in the absence of site-specific data, rather than surface irrigation, because the aerial spray leads to foliar deposition resulting in an additional source of radionuclide contamination in the plants and therefore yields conservative results. Trickle or flood irrigation systems can also be simulated, if desired. For atmospheric contamination, the pathway is assumed to be deposition of the airborne radionuclides onto the plant foliage and ground.

Concentrations of radionuclides in plants depend on the concentrations in the soil, air, and water. A plant accumulation factor is used to relate these concentrations. Concentrations of radionuclides in farm animal products, such as milk, meat, or eggs, depend on the animal's consumption of feed, forage, and water containing radionuclides.

Two radionuclides, H-3 and C-14, are treated differently than the others. These two are assumed to be in equilibrium with their surroundings. Thus, the concentration of tritium or carbon-14 in the hydrogen or carbon in biospheric media (soil, plants, and animal products) is assumed to have the same specific activity (pCi of nuclide per kg of stable element) as that of the contaminating medium (air or water).

External doses from radionuclides deposited in farm fields are calculated with the assumption of an infinite flat plane source model. For a person standing next to a body of contaminated water, the dose from nuclides deposited in the shoreline sediments is calculated by using the same model as that used for farm fields, modified to include a shore-width factor. For persons swimming in contaminated water, the dose is calculated by using the basic assumption that the body of contaminated water is large enough to be considered an infinite medium relative to the range of the emissions. Persons boating on the water are assumed to be exposed to a dose rate half that of swimmers.

Internal doses are calculated as a function of radionuclide concentration in food products, ingestion rates, and radionuclide-specific dose commitment factors. The concentration in foods can vary with time, release rate, and buildup and decay in the soil. The ingestion rate of food products is assumed to be constant. The dose commitment is calculated for each year of intake, to the end of the dose period. It is based on the model of International

Commission on Radiological Protection (ICRP) Publication 2 for internally deposited radionuclides.[20] The accumulated dose is then the sum of the series of annual dose commitments from each year of ingestion to the end of the dose period.

The computer program PABLM[16] has been used to calculate accumulated doses to 23 possible body organs or tissues for any one, or combination of, radionuclides. Five organs were selected in the analyses presented here.

The computer output consists of summaries of radiation dose to all chosen organs listed by exposure pathway and by radionuclide. Dose summaries were chosen for all terrestrial food pathways. In addition, a complete listing of dose contributions by radionuclide in each pathway was given.

Inhalation doses for the maximum individual were arrived at by multiplying the applicable X/Q value, shown in Table 2-5, by the appropriate Q's shown in Tables 2-1 and 2-2, and then by dose factors calculated for such use. These dose factors, with units of Sv/Bq (mrem/μCi) are contained in ICRP-30[21] and are shown in Table 2-9. The dose given by forming the product of X and the dose factor is a 70-year dose commitment to the various target organs affected by each radionuclide. For population dose calculations the location of groups of individuals enters the calculation by determining the release point/receptor location distance and the fraction of time the specified location is downward of the release point.

Submersion doses were evaluated for the maximum individual dose by taking the same concentrations as discussed above times dose factors calculated for such use. These dose factors, with units of Sv/y per Bq/cm^3 (mrem/y per μCi/cm^3), are shown in Table 2-10.[22] The considerations for extending a maximum individual dose to a population dose are the same as described above for the inhalation pathway.

To make all types of doses additive, the methods outlined in ICRP-26[23] have been applied to the PABLM[16] output, as well as results from submersion and inhalation dose calculations. Describing the dose addition technique, ICRP[23] states on page 21:

> "For stochastic effects the Commission's recommended dose limitation is based on the principle that the risk should be equal whether the whole body is irradiated uniformly or whether there is nonuniform irradiation.

"This condition will be met if

$$\Sigma_T W_T H_T \leq H_{wb,L}$$

where W_T is a weighting factor representing the proportion of the stochastic risk resulting from tissue (T) to the total risk, when the whole body is irradiated uniformly, H_T is the annual dose equivalent in tissue (T), $H_{wb,L}$ is the recommended annual dose-equivalent limit for uniform irradiation of the whole body.

Table 2-9. Inhalation Dose Factors

Radionuclide	Weighted Committed Dose Equivalent $\frac{Sv}{Bq}$		$\frac{mrem}{\mu Ci}$	
H-3	1.2×10^{-15}	$\frac{Sv\ m^3}{Bq\ hr}$	4.4×10^{-6}	$\frac{mrem\ cm^3}{yr\ \mu Ci}$
C-14	6.4×10^{-12}		2.4×10^{-2}	
Mn-54	1.7×10^{-9}		6.3	
Co-60	4.1×10^{-8}		$1.5 \times 10^{+2}$	
Ni-63	8.4×10^{-10}		3.1	
Kr-85	4.6×10^{-13}	$\frac{Sv\ m^3}{Bq\ hr}$	1.7×10^{-3}	$\frac{mrem\ cm^3}{yr\ \mu Ci}$
Sr-90	3.4×10^{-7}		$1.3 \times 10^{+3}$	
Y-90	2.2×10^{-9}		8.1	
Nb-95	1.2×10^{-9}		4.4	
Ru-106	1.2×10^{-7}		$4.4 \times 10^{+2}$	
Te-125m	1.8×10^{-9}		6.7	
I-129	4.7×10^{-8}		$1.7 \times 10^{+2}$	
Cs-134	1.3×10^{-8}		$4.8 \times 10^{+1}$	
Cs-137	8.7×10^{-9}		$3.2 \times 10^{+1}$	
Ce-144	9.5×10^{-8}		$3.5 \times 10^{+2}$	
Eu-154	7.0×10^{-8}		$2.6 \times 10^{+2}$	
Bi-210	5.1×10^{-8}		$1.9 \times 10^{+2}$	
Pb-210	3.4×10^{-6}		$1.3 \times 10^{+4}$	
Pb-212	4.2×10^{-8}		$1.6 \times 10^{+2}$	
Pb-214	1.8×10^{-9}		6.7	
Rn-220	-		-	
Rn-222	-		-	
Pu-238	1.2×10^{-4}		$4.4 \times 10^{+5}$	
Pu-239	1.4×10^{-4}		$5.2 \times 10^{+5}$	
Pu-240	1.4×10^{-4}		$5.2 \times 10^{+5}$	
Pu-241	2.8×10^{-6}		$1.0 \times 10^{+4}$	
Am-241	1.4×10^{-4}		$5.2 \times 10^{+5}$	
Cm-242	4.7×10^{-6}		$1.7 \times 10^{+4}$	
Cm-244	7.4×10^{-5}		$2.7 \times 10^{+5}$	

Table 2-10. Air Submersion Dose Factors

	Dose Conversion Factor $\frac{Sv}{year}\ \frac{Bq}{cm^3}$	Dose Conversion Factor $\frac{mrem}{year}\ \frac{\mu Ci}{cm^3}$	Weighted Dose Conversion Factor
H-3	0.0	0.0	0.0
C-14	5.88×10^{-5}	$2.18 \times 10^{+5}$	$1.31 \times 10^{+4}$
Mn-54	1.20	$4.44 \times 10^{+9}$	$2.66 \times 10^{+8}$
Co-60	3.55	$1.31 \times 10^{+10}$	$7.86 \times 10^{+8}$
Ni-63	0.0	0.0	0.0
Kr-85	7.18×10^{-3}	$2.66 \times 10^{+7}$	$1.60 \times 10^{+6}$
Sr-90	2.89×10^{-3}	$1.07 \times 10^{+7}$	$6.42 \times 10^{+5}$
Y-90	1.98×10^{-2}	$7.33 \times 10^{+7}$	$4.40 \times 10^{+6}$
Nb-95	1.09	$4.03 \times 10^{+9}$	$2.42 \times 10^{+8}$
Ru-106	0.0	0.0	0.0
Te-125	1.36×10^{-2}	$5.03 \times 10^{+7}$	$3.02 \times 10^{+6}$
I-129	1.16×10^{-2}	$4.29 \times 10^{+7}$	$2.57 \times 10^{+6}$
Cs-134	2.20	$8.14 \times 10^{+9}$	$4.88 \times 10^{+8}$
Cs-137	2.26×10^{-3}	$8.36 \times 10^{+6}$	$5.02 \times 10^{+5}$
Ce-144	2.55×10^{-2}	$9.44 \times 10^{+7}$	$5.66 \times 10^{+6}$
Eu-154	1.78	$6.59 \times 10^{+9}$	$3.95 \times 10^{+8}$
Bi-210	7.14×10^{-3}	$2.64 \times 10^{+7}$	$1.58 \times 10^{+6}$
Pb-210	1.85×10^{-3}	$6.85 \times 10^{+6}$	$4.11 \times 10^{+5}$
Pb-212	2.04×10^{-1}	$7.55 \times 10^{+8}$	$4.53 \times 10^{+7}$
Pb-214	3.45×10^{-1}	$1.28 \times 10^{+9}$	$7.68 \times 10^{+7}$
Rn-220	7.21×10^{-4}	$2.67 \times 10^{+6}$	$1.60 \times 10^{+5}$
Rn-222	5.34×10^{-4}	$1.98 \times 10^{+6}$	$1.19 \times 10^{+5}$
Pu-238	1.27×10^{-4}	$4.70 \times 10^{+5}$	$2.82 \times 10^{+4}$
Pu-239	1.15×10^{-4}	$4.26 \times 10^{+5}$	$2.56 \times 10^{+4}$
Pu-240	1.25×10^{-4}	$4.63 \times 10^{+5}$	$2.78 \times 10^{+4}$
Pu-241	0.0	0.0	0.0
Am-241	2.61×10^{-2}	$9.66 \times 10^{+7}$	$5.80 \times 10^{+6}$
Cm-242	1.42×10^{-4}	$5.25 \times 10^{+5}$	$3.15 \times 10^{+4}$
Cm-244	1.21×10^{-4}	$4.48 \times 10^{+5}$	$2.69 \times 10^{+4}$

"The values of W_T recommended by the Commission are shown below:

Tissue	W_T
Gonads	0.25
Breast	0.15
Red bone marrow	0.12
Lung	0.12
Thyroid	0.03
Bone surfaces	0.03
Remainder	0.30

"When external and internal exposures are received together, the Commission's recommended dose limitation for stochastic effects will not be exceeded if:

$$\frac{H_I}{H_{wb,L}} + \Sigma \frac{I_j}{I_{j,L}} \leq 1$$

where H_I is the annual dose-equivalent, $H_{wb,L}$ is the annual whole body dose-equivalent limit, I_j is the annual intake of radionuclide j, $I_{j,L}$ is the annual limit of intake for radionuclide j."

Population doses were calculated by first establishing the demography around each of the sites and formatting it to conform with the meteorological data. Specifically this means the division of the area within a 50-mile radius of the sites into 16 compass sectors and 0-5, 5-10, 10-20, 20-30, 30-40, and 40-50 mile annuli. Because the demographic data in the Environmental Characterization Reports for these sites[17,18,19,24] are most often in terms of county population densities and populations of major incorporated areas, the counties surrounding the sites are forced to conform to the boundaries of the population diagrams (Figures 2-1 to 2-6) with population centers located as they appear on a standard map.

The population number within each segment of the population diagram was calculated by (1) subtracting the contributions of population centers from the county population density, (2) multiplying the approximate county population density in persons/mi^2 by the number of square miles in each segment (this number is seen in every segment of the diagram), (3) recording in the

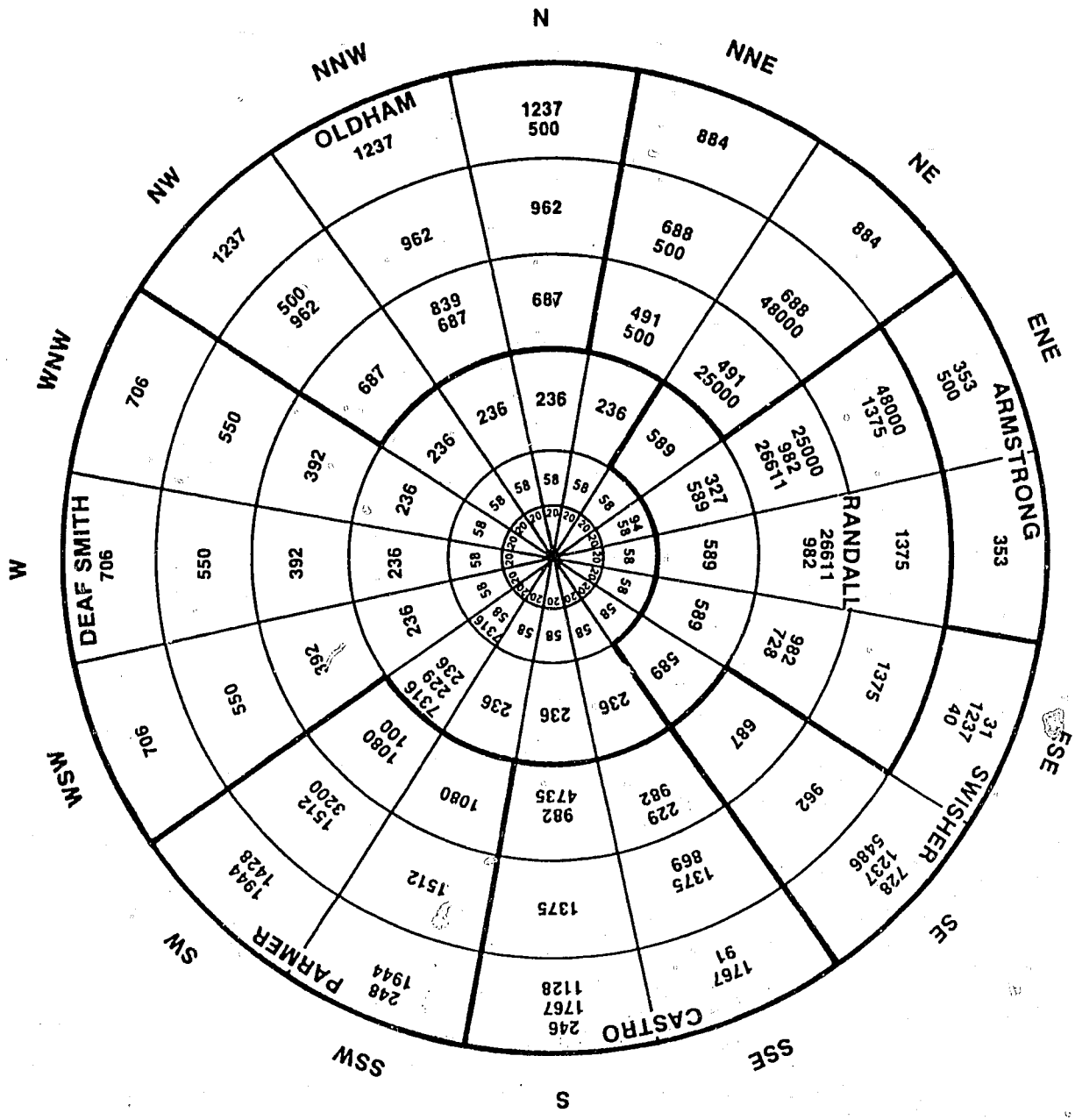

Figure 2-1. Deaf Smith County Site Population Distribution

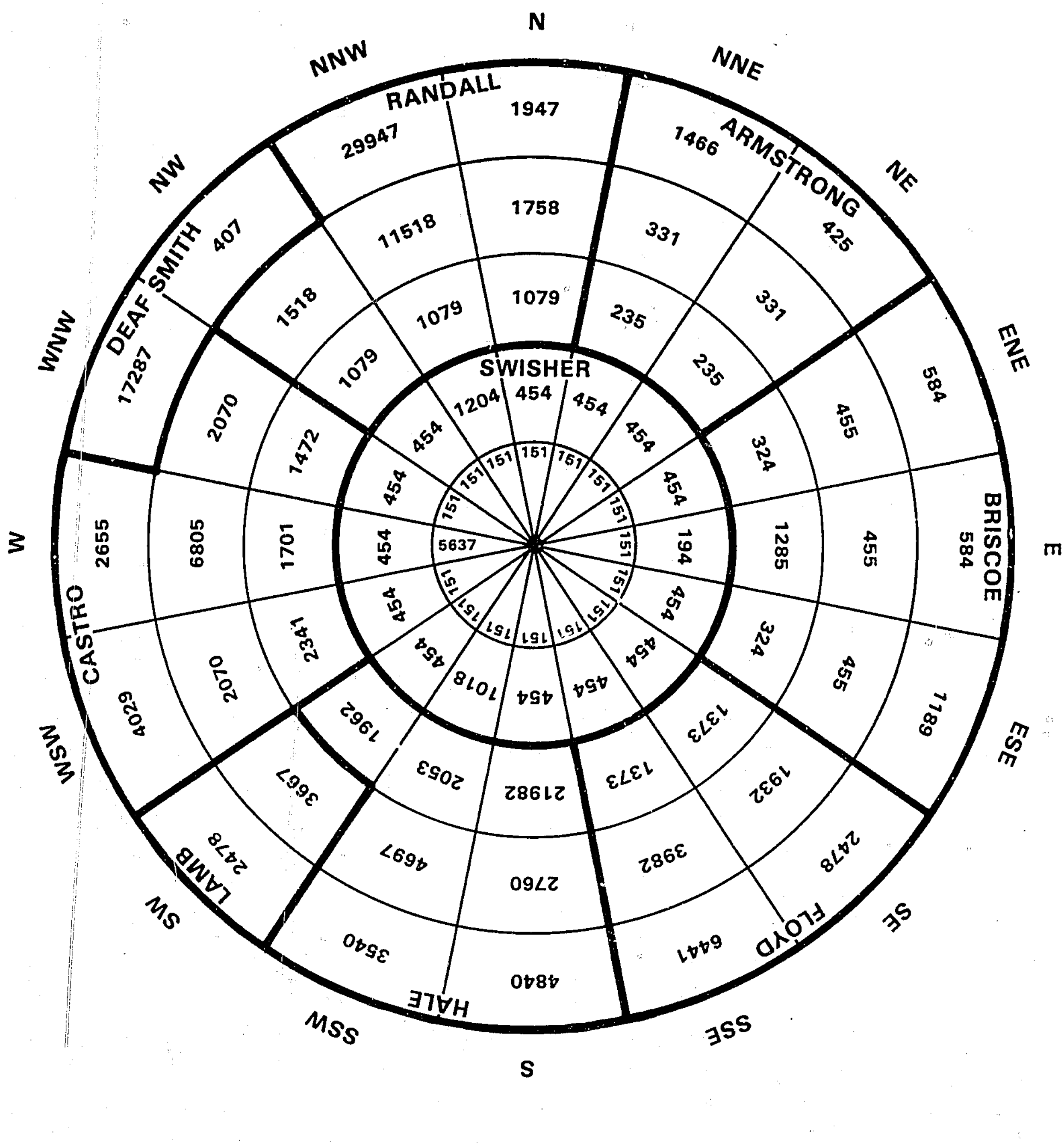

Figure 2-2. Swisher County Site Population Distribution

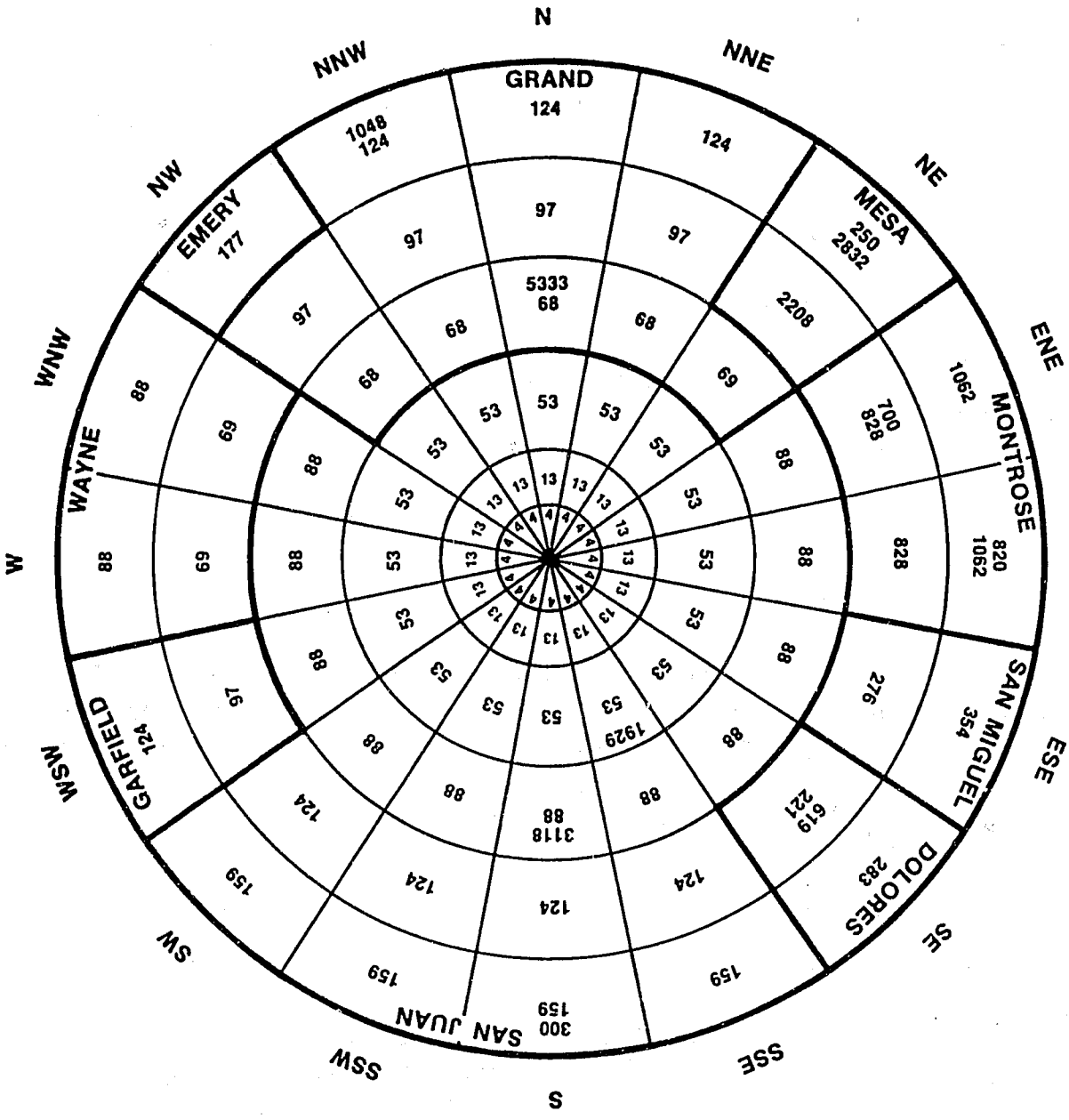

Figure 2-3. Utah Sites Population Distribution

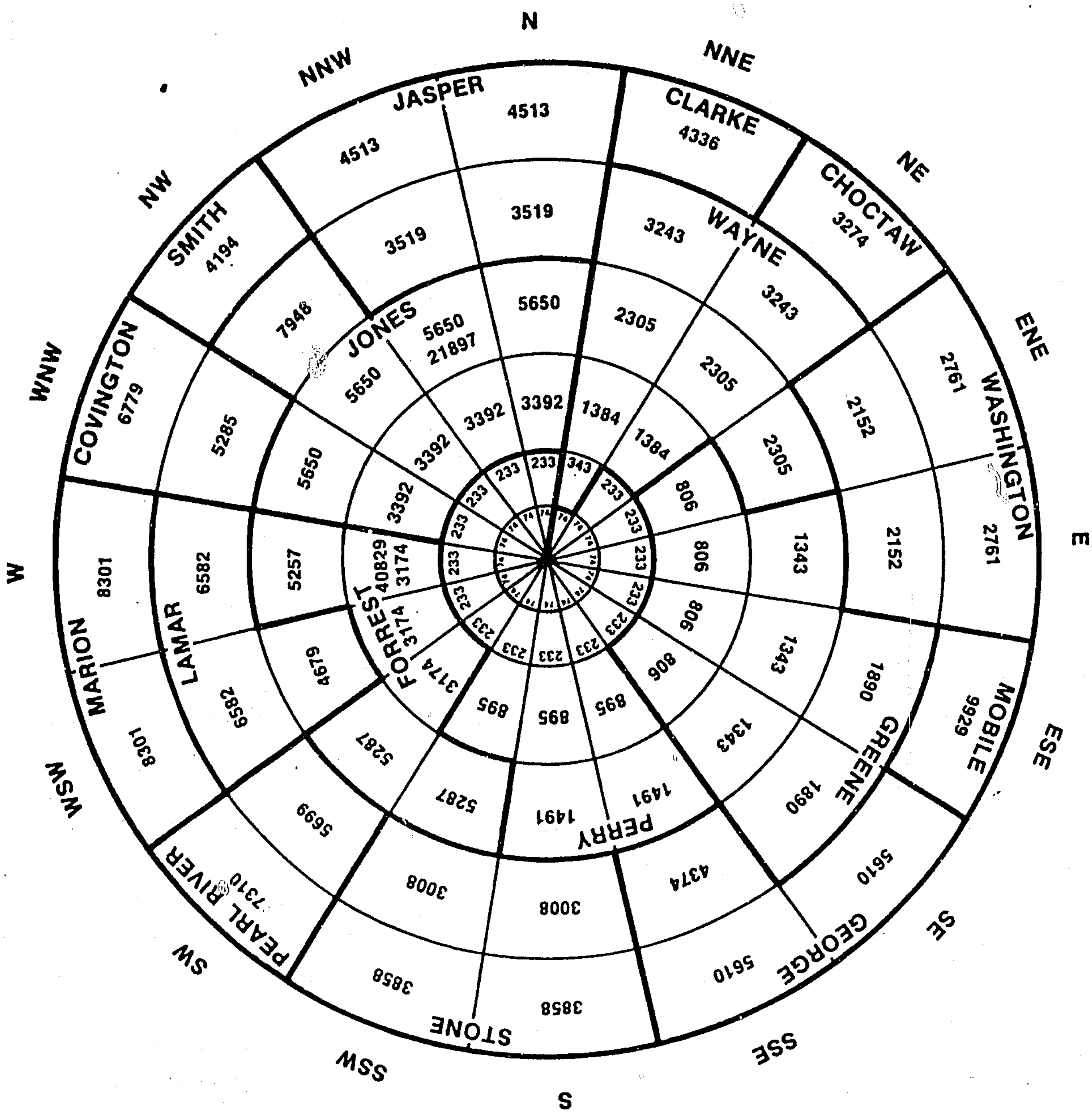

Figure 2-4. Richton Dome Site Population Distribution

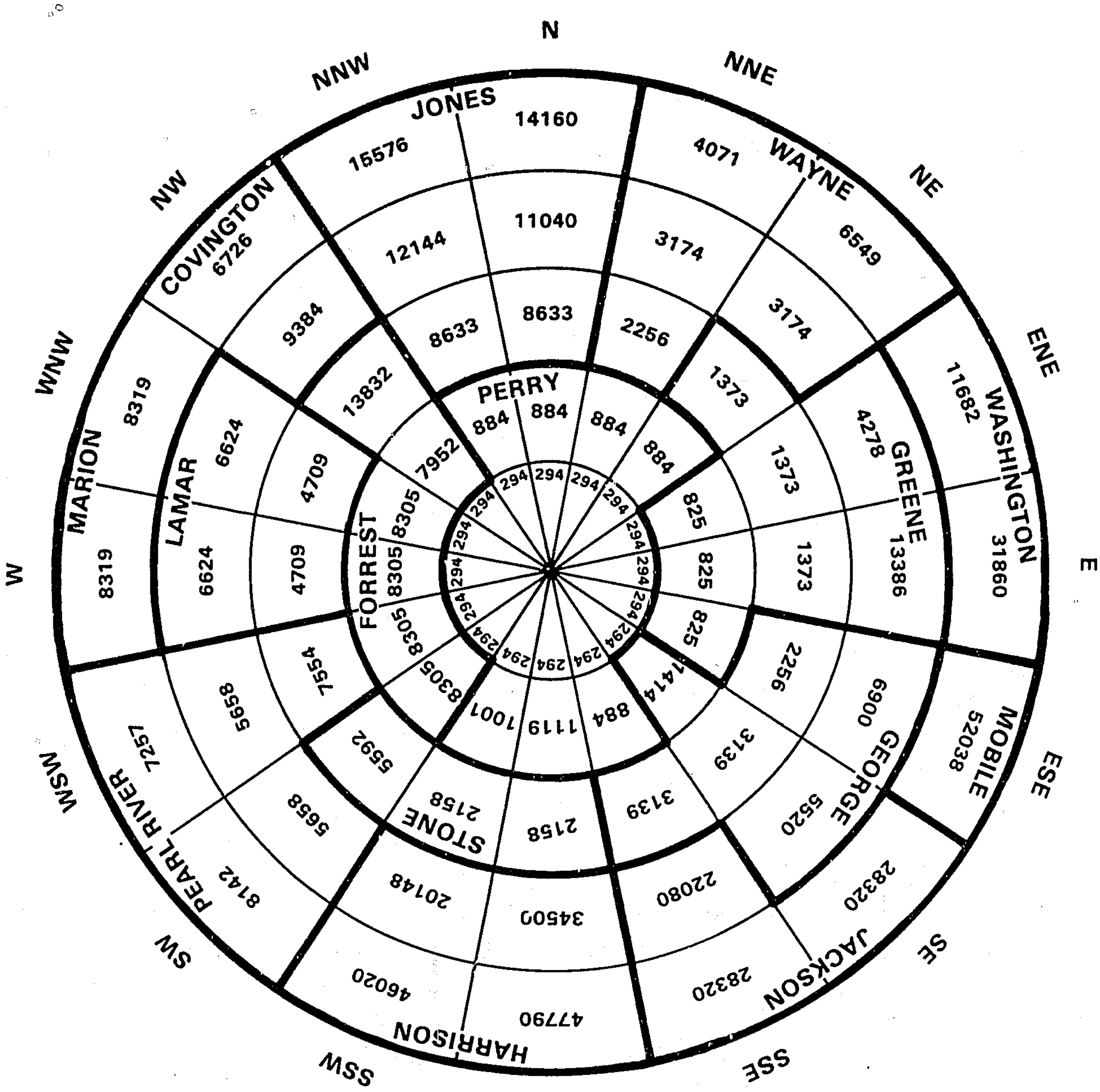

Figure 2-5. Cypress Creek Dome Site Population Distribution

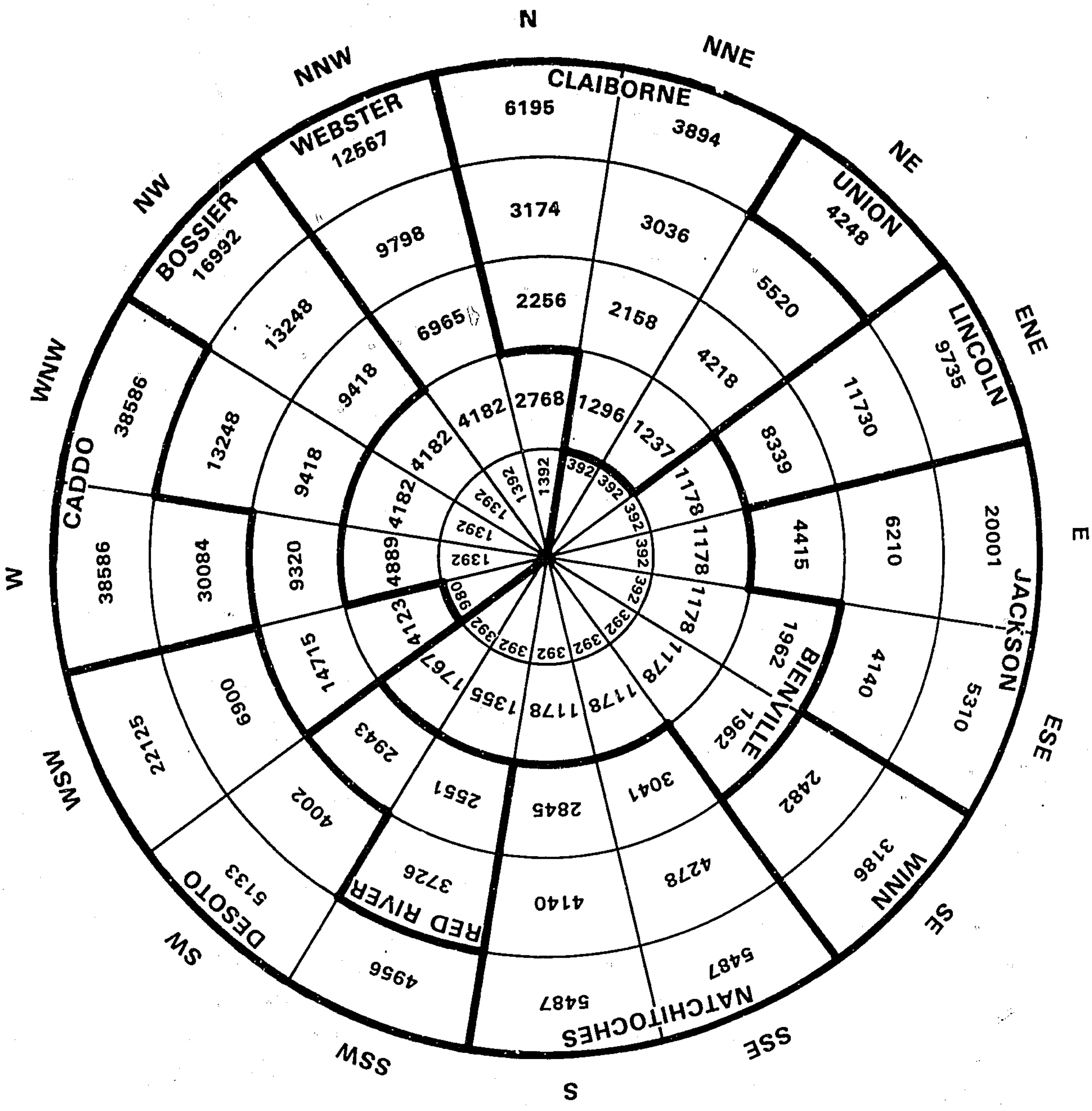

Figure 2-6. Vacherie Dome Site Population Distribution

appropriate segment all listed population centers, and (4) summing all population contributions within each segment.

The actual doses from each of the three exposure modes (food pathways, submersion, and inhalation) were calculated for each normal emission condition by taking the previously calculated maximum individual doses for each mode and modifying them by (1) multiplying by the ratio of the X/Q for the diagram segment involved (shown in Table 2-5) to the X/Q for the maximum individual to correspond to the site boundary (240 meters), and (2) multiplying the result by the number of people in that segment. Summing the result over all segments yields the population doses for each release condition. These maximum individual and population dose results for construction and operation are shown in Table 2-11. The critical nuclide(s) for construction emissions for the food pathways are Pb-210 and Bi-210; for inhalation, Bi-210; and for submersion, Pb-214. For operation, the food pathways doses are dominated by H-3 and I-129, inhalation by I-129, and submersion by Kr-85. It should be noticed that all calculated maximum individual doses are far below the 25 mrem dose limit.

Table 2-11. Doses for Normal Preclosure Conditions

Integration time	Exposure time	Palo Duro	Paradox (mrem or person-mrem)	Mississippi Gulf	Louisiana Gulf
			Construction		
Maximum Individual					
1	1*	4.5×10^{-3}	1.5×10^{-1}	9.0×10^{-3}	6.8×10^{-3}
70	8	3.5×10^{-2}	1.2	7.0×10^{-2}	5.3×10^{-2}
Population					
1	1	2.8×10^{-2}	6.7×10^{-2}	5.6×10^{-2}	1.7×10^{-1}
70	8	2.3×10^{-1}	5.2×10^{-1}	4.6×10^{-1}	1.3
			Operation		
Maximum Individual					
1	1	2.8×10^{-3}	1.0×10^{-1}	5.6×10^{-3}	4.2×10^{-3}
70	26	7.4×10^{-2}	2.7	1.5×10^{-1}	1.1×10^{-1}
Population					
1	1	1.8×10^{-2}	4.4×10^{-2}	3.6×10^{-2}	1.1×10^{-1}
70	26	4.9×10^{-1}	1.2	9.8×10^{-1}	2.8

* Note: The "1-1" indicates a 1-year dose from a 1-year exposure. This number is the one which should be compared with the 25 mrem whole-body limit. The 70-8 and 70-26 indicate a 70-year (or lifetime) dose commitment from total construction and operational emissions.

3 ACCIDENT CALCULATIONS

Based upon accident scenario development done in conjunction with the preparation of the Final Environmental Impact Statement for Commercial High-Level Waste[25] and subsequent work[26], five bounding accidents were analyzed to determine both the maximum exposed individual and the population doses involved. The U.S. Nuclear Regulatory Commission (NRC) gives strict guidance on how these calculations are to be done, and these analyses for the maximum individual are to be independent of the site. Such is not the case for population doses, where the demography is allowed to be site-specific.

For all sites as directed by the NRC, the meteorological conditions assumed were F stability class and 1 m/sec wind speed to conservatively portray poor dispersion conditions.[27] Using the same methods as were discussed previously for calculating X/Q values, the accident X/Q values shown in Table 3-1 were calculated for use in these analyses.

The radionuclide source terms used were as shown in Tables 3-2 to 3-6. The accidents were selected on the basis that collectively they represent the upper limits of offsite releases while at the same time indicating the range of such releases. The maximum exposed individual is assumed, for the routine emission cases, to be at the site fenceline (240 m). For population doses, the assumption is made that the release is into the most populous sector surrounding the release point. The 70-year dose commitment results are shown in Table 3-7. Table 3-8 lists the radionuclides which dominate the doses for each release situation and indicates the percent contribution of each exposure made to the total.

Table 3-1. Calculated X/Q Values for Accident Conditions

Distance [m]	X/Q [sec/m^3]
72,400	2.41×10^{-6}
56,300	3.11×10^{-6}
40,200	4.23×10^{-6}
24,100	6.31×10^{-6}
12,100	9.47×10^{-6}
4,020	1.38×10^{-5}
240	1.74×10^{-5}

Table 3-2. Releases From Shaft Drop of CHLW*

Radionuclide	Released Curies
Y-90	3.9×10^{-4}
Sr-90	3.9×10^{-4}
Ru-106	4.4×10^{-5}
Te-125	4.8×10^{-6}
Cs-134	8.0×10^{-5}
Cs-137	6.0×10^{-4}
Ce-144	2.0×10^{-5}
Eu-154	3.6×10^{-5}
Pu-238	5.6×10^{-7}
Pu-239	1.3×10^{-8}
Pu-240	5.2×10^{-8}
Pu-241	6.4×10^{-6}
Am-241	5.2×10^{-6}
Cm-244	4.4×10^{-5}

* The release is assumed to occur over a 1-hour time period. See Appendix A.

Table 3-3. Releases From Shaft Drop of Spent Fuel*

Radionuclide	Released Curies
H-3	9
C-14	6×10^{-2}
Kr-85	$6 \times 10^{+3}$
Sr-90	2×10^{-4}
Y-90	2×10^{-4}
I-129	9×10^{-3}
Cs-137	2×10^{-4}
Pu-238	6×10^{-6}
Pu-239	9×10^{-7}
Pu-240	1×10^{-6}
Pu-241	1.4×10^{-4}
Am-241	3.2×10^{-6}
Cm-244	1.8×10^{-6}

* The release is assumed to occur over a 1-hour time period. See Appendix A.

Table 3-4. Releases From Spent Fuel Handling Accident*

Radionuclide	Released Curies
H-3	5.4
C-14	3.6×10^{-2}
Kr-85	$3.6 \times 10^{+3}$
I-129	5.4×10^{-3}

* In this accident, the 12 PWR assemblies in a railcar cask are somehow crushed in the receiving building by a second cask. Because of filtration, virtually all of the particulate is contained. However, the gases are not totally filtered. It is assumed that 30 percent of the void gases in the pins would be released by the accident over a 30-minute time period. See Appendix A.

Table 3-5. Releases From Remote-Handled TRU Accident*

Radionuclide	Released Curies
H-3	2.5×10^{-1}
C-14	4.4×10^{-4}
Mn-54	8.1×10^{-8}
Co-60	1.6×10^{-6}
Ni-63	1.6×10^{-7}
Sr-90	1.2×10^{-8}
Nb-95	8.2×10^{-8}
Cs-137	1.9×10^{-8}
Pu-238	1.1×10^{-9}
Pu-239	7.2×10^{-11}
Pu-240	1.5×10^{-10}
Pu-241	3.6×10^{-8}
Am-241	1.4×10^{-10}
Cm-242	2.0×10^{-9}
Cm-244	1.4×10^{-9}

* The only credible accidents that happen with the remote-handled transuranic (RH-TRU) wastes (some 34,365 drums) are bounded in consequences by the shaft drop. In this accident, four canisters carrying three drums each dropped down the mine shaft and burst. Some 20 percent of the material is released over a period of 1 hour. See Appendix A.

Table 3-6. Releases From Contact-Handled TRU Accident*

Radionuclide	Released Curies
H-3	6.3×10^{-6}
C-14	1.6×10^{-10}
Co-60	6.2×10^{-13}
Sr-90	9.2×10^{-13}
Nb-95	1.1×10^{-11}
Ru-106	2.8×10^{-10}

* The most credible accident that can happen to contact-handled transuranic (CH-TRU) waste is the puncture of the drum and subsequent release of the drum's contents over a 30-minute time period. (See Appendix A.)

Table 3-7. Accident Dose Comparisons (mrem or person-mrem)

	Palo Duro	Paradox	Mississippi Gulf	Louisiana Gulf
Spent Fuel (SF)				
Maximum Individual	8.0×10^{-2}*	8.0×10^{-2}	8.0×10^{-2}	8.0×10^{-2}
Population	$1.8 \times 10^{+3}$	$1.1 \times 10^{+2}$	$1.7 \times 10^{+3}$	$1.6 \times 10^{+3}$
CHLW				
Maximum Individual	6.9×10^{-2}	6.9×10^{-2}	6.9×10^{-2}	6.9×10^{-2}
Population	$1.5 \times 10^{+3}$	$9.5 \times 10^{+1}$	$1.4 \times 10^{+3}$	$1.3 \times 10^{+3}$
SF Handling				
Maximum Individual	7.4×10^{-3}	7.4×10^{-3}	7.4×10^{-3}	7.4×10^{-3}
Population	$1.6 \times 10^{+2}$	$1.0 \times 10^{+1}$	$1.5 \times 10^{+2}$	$1.4 \times 10^{+2}$
RH-TRU				
Maximum Individual	7.6×10^{-6}	7.6×10^{-6}	7.6×10^{-6}	7.6×10^{-6}
Population	1.7×10^{-1}	1.0×10^{-2}	1.5×10^{-1}	1.4×10^{-1}
CH-TRU				
Maximum Individual	5.6×10^{-10}	5.6×10^{-10}	5.6×10^{-10}	5.6×10^{-10}
Population	1.2×10^{-5}	7.8×10^{-7}	1.1×10^{-5}	1.0×10^{-5}

* Doses are given in units of mrem or person-mrem.

Table 3-8. Critical Nuclides in Accident Releases

Food pathways	Submersion	Inhalation
	Spent Fuel (SF)	
H-3 Sr-90 Cs-137 Pu-238 Am-241	Kr-85	Pu-238 Pu-239 Pu-240 Pu-241 Am-241 Cm-244
(≈0%)	(10%)	(90%)
	CHLW	
Cs-134 Cs-137	Cs-134 Eu-154	Sr-90 Am-241 Cm-244
(≈0%)	(≈0%)	(≈100%)
	SF Handling	
H-3	Kr-85	I-129
(≈0%)	(42%)	(58%)
	RH-TRU	
H-3 Ni-63 Sr-90 Cs-137 Pu-238	Co-60	Co-60 Pu-238 Pu-239 Pu-240 Pu-241 Am-241 Cm-244
(≈0%)	(≈0%)	(≈100%)
	CH-TRU	
H-3 Sr-90 Ru-106	Co-60 Nb-95	Ru-106
(≈0%)	(≈0%)	(≈100%)

4 SUMMARY AND CONCLUSIONS

The results of these analyses indicate that a high-level nuclear waste repository placed at any one of the salt sites involved can comply with radiological regulations, where they exist. The summed contribution of all radionuclides emitted during construction equals 4×10^{-4} of the applicable 10 CFR Part 20[2] limit. For operation of such a repository, this sum is 10^{-2} of the limit. These values are not site specific because they were calculated at the release point, not at the site boundary.

The 40 CFR Part 191[4] radiological dose limit which is appropriate for comparison with the calculated estimates is 25 mrem/year for the maximum exposed individual. For construction, the largest sum of doses from all radionuclides and all exposure pathways for any site considered is 1.5×10^{-1} mrem/year. For operation, the analogous value is 1.0×10^{-1}. Population doses are always highest for Louisiana and lowest for the Palo Duro Basin.

For accidents analyzed, the range of maximum individual lifetime doses is 8.0×10^{-2} mrem to 5.6×10^{-10} mrem. The highest doses result from a drop of spent fuel down the shaft and the lowest from puncture of a contact-handled TRU drum. Population doses are always highest in the Palo Duro Basin and lowest in the Paradox Basin.

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6 REGULATIONS

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10 CFR Part 60, 1983. "Disposal of High-Level Radioactive Wastes in Geologic Repositories; Licensing Procedures".

10 CFR Part 960, 1984. "General Guidelines for Recommendation of Sites for Nuclear Waste Repositories", May 18 (to be codified).

40 CFR Part 960, 1982. "Environmental Radiation Protection Standards for Nuclear Power Operations".

40 CFR Part 191, 1984. "Environmental Radiation Protection Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Wastes" (Draft), February 1.

42 USC 10101, 1983. "Nuclear Waste Policy Act of 1982".

Department of Energy
Washington, D.C. 20585

MAY 14 1984

Honorable Nunzio J. Palladino
Chairman, Nuclear Regulatory
Commission
Washington, D.C. 20555

Dear Mr. Chairman:

This letter transmits the Department's siting guidelines with the revisions made in response to the Nuclear Regulatory Commission's (NRC) preliminary concurrence decision of March 14, 1984. We believe that these revisions fully satisfy the concerns of the Commission as expressed in its preliminary concurrence decision, and we look forward to receiving your concurrence as soon as possible.

In its preliminary concurrence decision, the Commission stated that it would concur in the siting guidelines provided that the Department complied with seven conditions. These seven conditions required the Department to (1) recognize the NRC's jurisdiction over the resolution of differences between the guidelines and 10 CFR Part 60; (2) commit to obtain NRC concurrence on guideline revisions relating to NRC jurisdiction; (3) make a number of specific revisions to the guidelines to enhance consistency between the guidelines and 10 CFR Part 60; (4) state more clearly that engineered barriers will not be used to compensate for site deficiencies; (5) specify in detail how the guidelines would be applied at each siting stage; (6) indicate, guideline by guideline, the kinds and levels of information necessary to make decisions on site nomination and recommendation for characterization; and (7) add more disqualifying conditions to the guidelines.

In developing responses to these conditions, the Department participated in a series of discussions with the NRC technical staff. The purpose of these meetings was to clearly understand both the meaning and the intent of the conditions as well as the revisions that would be required to satisfy the concurrence conditions. The discussions were open to the public, which was invited to comment at the end of each session.

In response to conditions 1 and 2, the Department has revised the "Applicability" section to acknowledge the NRC's jurisdiction for the resolution of differences between the guidelines and 10 CFR Part 60 and to state that the Department will obtain NRC concurrence on any guideline revisions relating to NRC jurisdiction. In response to condition 3, the Department has made a number of changes throughout the guidelines to ensure consistency between the guidelines and 10 CFR Part 60 and has stated its commitment to revise the guidelines as necessary to ensure consistency with the NRC's final regulations, when promulgated, for the unsaturated zone. In

response to condition 4, the Department has revised the discussion of engineered barriers in the implementation guidelines to more clearly state its intention that engineered barriers shall not be used to compensate for site deficiencies.

In response to condition 5, the Department revised the implementation guidelines to describe in more detail how the guidelines will be applied throughout the siting process. In addition, the Department has prepared a new Appendix C, which shows which guidelines will be applied at the principal decision points in siting and identifies the type of finding to be made when the guidclines are applied.

In response to condition 6, the Department has revised the implementation guidelines to add a new section describing the types and sources of information to be used in the principal siting decisions; the Department has also developed a new Appendix D, which lists the types of information that should be considered at the nomination stage for each technical guideline.

In response to condition 7, the Department has added to the technical guidelines six new disqualifying conditions: two for the postclosure guidelines (tectonics and natural resources) and four for the preclosure guidelines (offsite installations and operations, socioeconomic impacts, hydrology, and tectonics). The Department has also revised the disqualifying condition for the preclosure environmental quality guideline to include National Forest Lands. Thus, the siting guidelines now contain an explicit disqualifying condition for each of the factors specified in Section 112(a) of the Nuclear Waste Policy Act.

The revisions summarized above are included in the line-in/line-out version of the guidelines attached for the Commission's consideration. The revisions address each of the concurrence conditions and, in our opinion, have significantly clarified the siting process.

We appreciate the effort on the part of the Commission to reach concurrence on the siting guidelines; we also appreciate and commend the diligence of the NRC technical staff in this matter. Because issuance of the Department's siting guidelines has become a critical milestone in the repository program, we would greatly appreciate any effort by the Commission to expedite its concurrence on the guidelines.

Sincerely yours,

Michael J. Lawrence

Michael J. Lawrence
Acting Director
Office of Civilian Radioactive Waste
Management

Enclosures

cc: Samuel Chilk
John Davis

APPENDIX A

DOE REVISIONS
TO
GENERAL GUIDELINES FOR RECOMMENDATION OF SITES FOR NUCLEAR WASTE REPOSITORIES
(NOVEMBER 18, 1983, FINAL DRAFT)

IN RESPONSE TO

THE PRELIMINARY DECISION ON CONCURRENCE
BY THE NRC ON MARCH 14, 1984

MAY 14, 1984

SUMMARY OF THE REVISIONS TO THE SITING GUIDELINES

The revisions to the siting guidelines of November 18, 1983, are attached in the following order and format:

- Subpart A--GENERAL PROVISIONS: Line-in additions and line-out deletions.
- Subpart B--IMPLEMENTATION GUIDELINES: Line-in additions and line-out deletions.
- Subpart C--POSTCLOSURE GUIDELINES: Line-in additions and line-out deletions.
- Subpart D--PRECLOSURE GUIDELINES: Line-in additions and line-out deletions.
- APPENDICES: Additions are Appendix III--APPLICATION OF THE SYSTEM AND TECHNICAL GUIDELINES DURING THE SITING PROCESS--and Appendix IV--TYPES OF INFORMATION FOR THE NOMINATION OF SITES AS SUITABLE FOR CHARACTERIZATION.

Additionally, an index of DOE responses to the seven NRC preliminary concurrence conditions is given on the following pages.

INDEX OF DOE RESPONSES TO NRC PRELIMINARY CONCURRENCE CONDITIONS

	NRC PRELIMINARY CONCURRENCE CONDITION	DOE SITING GUIDELINES				
		SUBPART A	SUBPART B	SUBPART C	SUBPART D	APPENDIX
(1)	NRC jurisdiction for resolution of differences	Revisions of 960.1				
(2)	NRC concurrence on revisions to siting guidelines	Revision of 960.1				
(3)(a)	Modify use of high effective porosity			Deletion of 960.4-2 1(b)(4); addition to 960.4-2-1(b)(4) (iv)		
(3)(b)	Unsaturated zone revisions for consistency with NRC amendments			Addition to 960.4-2 1(b)(5)		
(3)(c)	Dissolved solid concentrations in groundwater			Deletion of 960.4-2-1(b)(7); addition of 960.4-2-8 1(b)(2)		

INDEX OF DOE RESPONSES TO NRC PRELIMINARY CONCURRENCE CONDITIONS (CONT'D)

NRC PRELIMINARY CONCURRENCE CONDITION	DOE SITING GUIDELINES				
	SUBPART A	SUBPART B	SUBPART C	SUBPART D	APPENDIX
(3)(d) Adjustment of 1,000-year groundwater travel time			Revision of 960.4-2-1(d)		
(3)(e) Delete "permanently" from "disturbed zone" definition	Deletion from 960.2				
(3)(f) Clarify "short-term" extreme erosion			Deletion of "sustained" from 960.4-2-8-1(c)(2)		
(3)(g) Delete "significant" from 960.4-2-8-1(c)(2)			Deletion of "significant" from 960.4-2-8-1(c)(2)		
(3)(h) Modifications for consistency with "anticipated..." and "unanticipated..."	Deletion of definitions from 960.2	Deletion from 960.3-1 §	Deletion from 960.4-2		

INDEX OF DOE RESPONSES TO NRC PRELIMINARY CONCURRENCE CONDITIONS (CONT'D)

NRC PRELIMINARY CONCURRENCE CONDITION	DOE SITING GUIDELINES				
	SUBPART A	SUBPART B	SUBPART C	SUBPART D	APPENDIX
(3)(i) Potentially adverse conditions outside controlled area			Addition to 960.4 2; revision of 960.4 2 6(c)		
(4) Engineered barriers cannot constitute compensating measures for site deficiencies		Revision of 960.3 1 5[4]	Revision of 960.4-1(a)		
(5) Guideline application during siting process	Addition of definitions to 960.2	Revision of 960.3 2 1 through 960.3 2-4			Addition of Appendix C (GL Application)
(6) Kinds of information for siting decisions		Addition of 960.3 1 4 (Evidence)			Addition of Appendix D (Types of Information)
(7) Additional disqualifying conditions for factors given in NWPA 112(a)			Additions to 960.4-2 7(d) and 960.4-2-8-1(d)(2); revision of 960.4-2 6(d)	Additions to 960.5-2-4(d), 960.5-2-5(d)(3), 960.5-2-6(d), 960.5-2-10(d), 960.5-2-11(d)	

SUMMARY OF THE REVISIONS TO SUBPART A

The following is the line-in/line-out revision of Subpart A--GENERAL PROVISIONS--of the DOE siting guidelines of November 18, 1983. Additions to that version are underlined. To avoid confusion, all words, phrases, or headings that were underlined in the version of November 18, 1983, have been replaced by capital letters with underlining. Deletions are enclosed in brackets and crossed out, as for example ~~[permanently]~~.

Deletions include the removal from Section 960.1, APPLICABILITY, of language dealing with consistency among regulations, and the removal of the definitions of "characteristics and processes affecting expected repository performance" and "potentially disruptive processes and events", and the word "permanently" from the definition of "disturbed zone" in Section 960.2, DEFINITIONS.

Additions include the insertion of new language in Section 360.1, APPLICABILITY, dealing with NRC jurisdiction and definitions of "application," "determination," "evaluation," and "finding" in Section 960.2, DEFINITIONS.

SUBPART A--GENERAL PROVISIONS.

960.1 APPLICABILITY.

These guidelines were developed in accordance with the requirements of Section 112(a) of the Nuclear Waste Policy Act of 1982 for use by the Secretary of Energy in evaluating the suitability of sites for the development of repositories. The guidelines will be used for suitability evaluations and determinations made pursuant to Section 112(b) and any preliminary suitability determinations required by Section 114(f).

The guidelines set forth in this Part are intended to complement the requirements set forth in the Act, 10 CFR Part 60, and 40 CFR Part 191. ~~[In applying these guidelines, the DOE will resolve any inconsistencies between these guidelines and the above documents in a manner determined by the DOE to most closely agree with the intent of the Act.]~~ The DOE recognizes NRC jurisdiction for the resolution of differences between the guidelines and 10 CFR Part 60. The guidelines have received the concurrence of the NRC. The DOE contemplates revising the guidelines from time to time, as permitted by the Act, to take into account revisions made to the above regulations and to otherwise update the guidelines as necessary. The DOE will submit any such revisions relating to NRC jurisdiction to the NRC and obtain its concurrence before issuance.

960.2 DEFINITIONS.

As used in this Part:

"Accessible environment" means the atmosphere, the land surface, surface water, oceans, and the portion of the lithosphere that is outside the controlled area.

"Act" means the Nuclear Waste Policy Act of 1982.

"Active fault" means a fault along which there is recurrent movement, which is usually indicated by small, periodic displacements or seismic activity.

"Affected area" means either the area of socioeconomic impact or the area of environmental impact, each of which will vary in size among potential repository sites.

"Affected Indian tribe" means any Indian tribe (1) within whose reservation boundaries a repository for radioactive waste is proposed to be located or (2) whose federally defined possessory or usage rights to other lands outside the reservation's boundaries arising out of congressionally ratified treaties may be substantially and adversely affected by the locating of such a facility: PROVIDED that the Secretary of the Interior finds, upon the petition of the appropriate governmental officials of the tribe, that such effects are both substantial and adverse to the tribe.

"Affected State" means any State that (1) has been notified by the DOE in accordance with Section 116(a) of the Act as ~~[encompassing]~~ containing a

potentially acceptable site; (2) contains a candidate site for site characterization or repository development; or (3) contains a site selected for repository development.

"Application" means the act of making a finding of compliance or noncompliance with the qualifying or disqualifying conditions specified in the guidelines of Subparts C and D, in accordance with the types of findings specified in Appendix III.

"Aquifer" means a formation, a group of formations, or a part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs.

"Barrier" means any material or structure that prevents or substantially delays the movement of water or radionuclides.

"Candidate site" means an area, within a geohydrologic setting, that is recommended by the Secretary of Energy under Section 112 of the Act for site characterization, approved by the President under Section 112 of the Act for characterization, or undergoing site characterization under Section 113 of the Act.

~~["Capillary fringe" means the zone immediately above the water table in which all or some of the interstices are filled with water that is under less than atmospheric pressure and that is continuous with the water below the water table.]~~

~~["Characteristics and processes affecting expected repository performance" means those natural characteristics and processes that are reasonably likely to exist or occur in the geologic setting during the period over which the intended performance objective must be achieved. To the extent reasonable on the basis of the geologic record, it shall be assumed that those characteristics and processes existing and/or operating during the Quaternary Period will continue to exist and/or operate, but with the perturbations induced by the presence of the repository superimposed thereon.]~~

"Closure" means final backfilling of the remaining open operational areas of the underground facility and boreholes after the termination of waste emplacement, culminating in the sealing of shafts.

"Confining unit" means a body of impermeable or distinctly less permeable material stratigraphically adjacent to one or more aquifers.

"Containment" means the confinement of radioactive waste within a designated boundary.

"Controlled area" means a surface location, to be marked by suitable monuments, extending horizontally no more than 10 kilometers in any direction from the outer boundary of the underground facility, and the underlying subsurface, which area has been committed to use as a geologic repository and from which incompatible activities would be prohibited before and after permanent closure.

"Cumulative releases of radionuclides" means the total number of curies of radionuclides entering the accessible environment in any 10,000-year period, normalized on the basis of radiotoxicity in accordance with 40 CFR Part 191. The peak cumulative release of radionuclides refers to the 10,000-year period during which any such release attains its maximum ~~{projected}~~ predicted value.

"Decommissioning" means the permanent removal from service of surface facilities and components necessary for preclosure operations only, after repository closure, in accordance with regulatory requirements and environmental policies.

"Determination" means a decision by the Secretary that a site is suitable for site characterization for the selection of a repository site or that a site is suitable for the development of a repository, consistent with applications of the guidelines of Subparts C and D in accordance with the provisions set forth in Subpart B.

"Disposal" means the emplacement in a repository of high-level radioactive waste, spent nuclear fuel, or other highly radioactive material with no foreseeable intent of recovery, whether or not such emplacement permits the recovery of such waste, and the isolation of such waste from the accessible environment.

"Disqualifying condition" means a condition that, if present at a site, would eliminate that site from further consideration.

"Disturbed zone" means that portion of the controlled area, excluding shafts, whose physical or chemical properties are ~~{projected}~~ predicted to change ~~{permanently}~~ as a result of underground facility construction or heat generated by the emplaced radioactive waste such that the resultant change of properties could have a significant effect on the performance of the geologic repository.

"DOE" means the U.S. Department of Energy or its duly authorized representatives.

"Effective porosity" means the amount of interconnected pore space and fracture openings available for the transmission of fluids, expressed as the ratio of the volume of interconnected pores and openings to the volume of rock.

"Engineered-barrier system" means the manmade components of a disposal system designed to prevent the release of radionuclides from the underground facility or into the geohydrologic setting. Such term includes the radioactive-waste form, radioactive-waste canisters, materials placed over and around such canisters, any other components of the waste package, and barriers used to seal penetrations in and into the underground facility.

"Environmental assessment" means the document required by Section 112(b,(1)(E) of the Nuclear Waste Policy Act of 1982.

"Environmental impact statement" means the document required by Section 102(2)(C) of the National Environmental Policy Act of 1969. Sections 114(a) and 114(f) of the Nuclear Waste Policy Act of 1982 include certain limitations

[~~of~~] on the National Environmental Policy Act requirements as they apply to the preparation of an environmental impact statement for the development of a repository at a characterized site.

"EPA" means the U.S. Environmental Protection Agency or its duly authorized representatives.

"Evaluation" means the act of carefully examining the characteristics of a site in relation to the requirements of the qualifying or disqualifying conditions specified in the guidelines of Subparts C and D. Evaluation includes the consideration of favorable and potentially adverse conditions.

"Expected" means assumed to be probable or certain on the basis of existing evidence and in the absence of significant evidence to the contrary.

"Expected repository performance" means the manner in which the repository is [~~projected~~] predicted to function, considering those conditions, processes, and events that are [~~most~~] likely to prevail or may occur during the time period of interest.

"Facility" means any structure, system, or system component, including engineered barriers, created by the DOE to meet repository-performance or functional objectives.

"Fault" means a fracture or a zone of fractures along which there has been displacement of the sides relative to one another parallel to the fracture or zone of fractures.

"Faulting" means the process of fracturing and displacement that produces a fault.

"Favorable condition" means a condition that, though not necessary to qualify a site, is presumed, if present, to enhance confidence that the qualifying condition of a particular guideline can be met.

"Finding" means a conclusion that is reached after evaluation.

"Geohydrologic setting" means the system of geohydrologic units that is located within a given geologic setting.

"Geohydrologic system" means the geohydrologic units within a geologic setting, including any recharge, discharge, interconnections between units, and any natural or man-induced processes or events that could affect ground-water flow within or among those units.

"Geohydrologic unit" means an aquifer, a confining unit, or a combination of aquifers and confining units comprising a framework for a reasonably distinct geohydrologic system.

"Geologic repository" means a system, requiring licensing by the NRC, that is intended to be used, or may be used, for the disposal of radioactive waste in excavated geologic media. A geologic repository includes (1) the geologic-repository operations area and (2) the portion of the geologic

setting that provides isolation of the radioactive waste and is located within the controlled area.

"Geologic-repository operations area" means a radioactive-waste facility that is part of the geologic repository, including both surface and subsurface areas and facilities where waste-handling activities are conducted.

"Geologic setting" means the geologic, hydrologic, and geochemical systems of the region in which a geologic-repository operations area is or may be located.

"Geomorphic processes" means geologic processes that are responsible for the general configuration of the Earth's surface, including the development of present landforms and their relationships to underlying structures, and are responsible for the geologic changes recorded by these surface features.

~~["Governor" means the chief executive officer of a State.]~~

"Ground water" means all subsurface water as distinct from surface water.

"Ground-water flux" means the rate of ground-water flow per unit area of porous or fractured media measured perpendicular to the direction of flow.

"Ground-water sources" means aquifers that have been or could be economically and technologically developed as sources of water in the foreseeable future.

"Ground-water travel time" means the time required for a unit volume of ground water to travel between two locations. The travel time is the length of the flow path divided by the velocity, where velocity is the average ground-water flux passing through the cross-sectional area of the geologic medium through which flow occurs, perpendicular to the flow direction, divided by the effective porosity along the flow path. If discrete segments of the flow path have different hydrologic properties, the total travel time will be the sum of the travel times for each discrete segment.

"Guideline" means a statement of policy or procedure that may include, when appropriate, qualifying, disqualifying, favorable, or potentially adverse conditions as specified in the "guidelines."

"Guidelines" means Part 960 of Title 10 of the Code of Federal Regulations--General Guidelines for the Recommendation of Sites for Nuclear Waste Repositories.

"High-level radioactive waste" means (1) the highly radioactive material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations and (2) other highly radioactive material that the NRC, consistent with existing law, determines by rule requires permanent isolation.

"Highly populated area" means any incorporated place (recognized by the decennial reports of the U.S. Bureau of the Census) of 2,500 or more persons, or any census designated place (as defined and delineated by the Bureau) of

2,500 or more persons, unless it can be demonstrated that any such place has a lower population density than the mean value for the continental United States. Counties or county equivalents, whether incorporated or not, are specifically excluded from the definition of "place" as used herein.

"Host rock" means the geologic medium in which the waste is emplaced, specifically the geologic materials that directly encompass and are in close proximity to the underground facility.

"Hydraulic conductivity" means the volume of water that will move through a medium in a unit time under a unit hydraulic gradient through a unit area measured perpendicular to the direction of flow.

"Hydraulic gradient" means a change in the static pressure of ground water, expressed in terms of the height of water above a datum, per unit of distance in a given direction.

"Hydrologic process" means any hydrologic phenomenon that exhibits a continuous change in time, whether slow or rapid.

"Hydrologic properties" means those properties of a rock that govern the entrance of water and the capacity to hold, transmit, and deliver water, such as porosity, effective porosity, specific retention, permeability, and the directions of maximum and minimum permeabilities.

"Igneous activity" means the emplacement (intrusion) of molten rock material (magma) into material in the Earth's crust or the expulsion (extrusion) of such material onto the Earth's surface or into its atmosphere or surface water.

"Isolation" means inhibiting the transport of radioactive material so that the amounts and concentrations of this material entering the accessible environment will be kept within prescribed limits.

"Likely" means possessing or displaying the qualities, characteristics, or attributes that provide a reasonable basis for confidence that what is expected indeed exists or will occur.

"Lithosphere" means the solid part of the Earth, including any ground water contained within it.

"Member of the public" means any individual who is not engaged in operations involving the management, storage, and disposal of radioactive waste. A worker so engaged is a member of the public except when on duty at the geologic-repository operations area.

"Mitigation" means (1) avoiding the impact altogether by not taking a certain action or parts of an action; (2) minimizing impacts by limiting the degree or magnitude of the action and its implementation; (3) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; (4) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; or (5) compensating for the impact by replacing or providing substitute resources or environments.

"Model" means a conceptual description and the associated mathematical representation of a system, subsystem, component, or condition that is used to predict changes from a baseline state as a function of internal and/or external stimuli and as a function of time and space.

"NRC" means the U.S. Nuclear Regulatory Commission or its duly authorized representatives.

"Perched ground water" means unconfined ground water separated from an underlying body of ground water by an unsaturated zone. Its water table is a perched water table. Perched ground water is held up by a perching bed whose permeability is so low that water percolating downward through it is not able to bring water in the underlying unsaturated zone above atmospheric pressure.

"Performance assessment" means any analysis that predicts the behavior of a system or system component under a given set of constant and/or transient conditions. Performance assessments will include estimates of the effects of uncertainties in data and modeling.

"Permanent closure" is synonymous with "closure."

"Postclosure" means the period of time after the closure of the geologic repository.

"Potentially acceptable site" means any site at which, after geologic studies and field mapping but before detailed geologic data gathering, the DOE undertakes preliminary drilling and geophysical testing for the definition of site location.

"Potentially adverse condition" means a condition that is presumed to detract from expected system performance ~~[unless]~~, but further evaluation, additional data, or the identification of compensating or mitigating factors may indicate~~[s]~~ that its effect on the expected system performance is acceptable.

~~["Potentially disruptive processes and events" means those natural processes and events, or processes and events initiated by human activities, affecting the geologic setting that are judged to be reasonably unlikely to occur during the period over which the intended performance objective must be achieved, but that are nevertheless sufficiently credible to warrant consideration.]~~

"Preclosure" means the period of time before and during the closure of the geologic repository.

"Pre-waste-emplacement" means before the authorization of repository construction by the NRC.

"Qualifying condition" means a condition that must be satisfied for a site to be considered acceptable with respect to a specific guideline.

"Quaternary Period" means the second period of the Cenozoic Era, following the Tertiary, beginning 2 to 3 million years ago and extending to the present.

"Radioactive waste" or "waste" means high-level radioactive waste and other radioactive materials, including spent nuclear fuel, that are received for emplacement in a geologic repository.

"Radioactive-waste facility" means a facility subject to the licensing and related regulatory authority of the NRC pursuant to Sections 202(3) and 202(4) of the Energy Reorganization Act of 1974 (88 Stat. 1244).

"Radionuclide retardation" means the process or processes that cause the time required for a given radionuclide to move between two locations to be greater than the ground-water travel time, because of physical and chemical interactions between the radionuclide and the geohydrologic unit through which the radionuclide travels.

"Reasonably available technology" means technology ~~[that]~~ which exists and has been demonstrated or for which the results of any requisite development, demonstration, or confirmatory testing efforts before application will be available within the required time periods.

"Repository" is synonymous with "geologic repository."

"Repository closure" is synonymous with "closure."

"Repository construction" means all excavation and mining activities associated with the construction of shafts, shaft stations, rooms, and necessary openings in the underground facility, preparatory to radioactive-waste emplacement, as well as the construction of necessary surface facilities, but excluding site-characterization activities.

"Repository operation" means all of the functions at the site leading to and involving radioactive-waste emplacement in the underground facility, including receiving, transportation, handling, emplacement, and, if necessary, retrieval.

"Repository support facilities" means all permanent facilities constructed in support of site-characterization activities and repository construction, operation, and closure activities, including surface structures, utility lines, roads, railroads, and similar facilities, but excluding the underground facility.

"Restricted area" means any area access to which is controlled by the DOE for purposes of protecting individuals from exposure to radiation and radioactive materials before repository closure, but not including any areas used as residential quarters, although a separate room or rooms in a residential building may be set apart as a restricted area.

"Retrieval" means the act of intentionally removing radioactive waste before repository closure from the underground location at which the waste had been previously emplaced for disposal.

"Saturated zone" means that part of the Earth's crust beneath the water table in which all voids, large and small, are ideally filled with water under pressure greater than atmospheric.

"Secretary" means the Secretary of Energy.

"Site" means a potentially acceptable site or a candidate site, as appropriate, until such time as the controlled area has been established, at which time the site and the controlled area are the same.

"Site characterization" means activities, whether in the laboratory or in the field, undertaken to establish the geologic conditions and the ranges of the parameters of a candidate site relevant to the location of a repository, including borings, surface excavations, excavations of exploratory shafts, limited subsurface lateral excavations and borings, and in situ testing needed to evaluate the suitability of a candidate site for the location of a repository, but not including preliminary borings and geophysical testing needed to assess whether site characterization should be undertaken.

"Siting" means the collection of exploration, testing, evaluation, and decision-making activities associated with the process of site screening, site nomination, site recommendation, and site approval for characterization or repository development.

"Source term" means the kinds and amounts of radionuclides that make up the source of a potential release of radioactivity.

"Spent nuclear fuel" means fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated by reprocessing.

"Surface facilities" means repository support facilities within the restricted area.

"Surface water" means any waters on the surface of the Earth, including fresh and salt water, ice, and snow.

"System" means the geologic setting at the site, ~~[engineered components, and associated processes and events that affect expected repository performance]~~ the waste package, and the repository, ~~[considered as an integrated entity]~~ all acting together to contain and isolate the waste.

"System performance" means the ~~[total, integrated result of all acting]~~ complete behavior of a repository system in response to the conditions, processes, and events ~~[caused by or affecting a repository]~~ that may affect it.

"Tectonic" means of, or pertaining to, the forces involved in, or the resulting structures or features of, "tectonics."

"Tectonics" means the branch of geology dealing with the broad architecture of the outer part of the Earth, that is, the regional assembling of structural or deformational features and the study of their mutual relations, origin, and historical evolution.

"To the extent practicable" means the degree to which an intended course of action is capable of being effected in a manner that is reasonable and feasible within a framework of constraints.

"Underground facility" means the underground structure and the rock required for support, including mined openings and backfill materials, but excluding shafts, boreholes, and their seals.

"Unsaturated zone" means the zone between the land surface and the water table. ~~[It includes the "capillary fringe".]~~ Generally, water in this zone is under less than atmospheric pressure, and some of the voids may contain air or other gases at atmospheric pressure. Beneath flooded areas or in perched water bodies, the water pressure locally may be greater than atmospheric.

"Waste form" means the radioactive waste materials and any encapsulating or stabilizing matrix.

"Waste package" means the waste form and any containers, shielding, packing, and other sorbent materials immediately surrounding an individual waste container.

"Water table" means that surface in a body of ground water at which the water pressure is atmospheric.

DOE REVISIONS

TO

SUBPART B--IMPLEMENTATION GUIDELINES--OF THE SITING GUIDELINES OF NOVEMBER 18, 1983

SUMMARY OF PROPOSED REVISIONS TO SUBPART B

Attached is the line-in/line-out revision of Subpart B--IMPLEMENTATION GUIDELINES--of the DOE siting guidelines of November 18, 1983. Additions to that version are underlined. To avoid confusion, all words, phrases, or headings that were underlined in the version of November 18, 1983, have been replaced by capital letters with underlining. Deletions are enclosed in brackets and crossed out, as for example [..~~an engineered barrier system~~...].

Regarding the format of Subpart B, a new Section 960.3-1-4, entitled EVIDENCE FOR SITING DECISIONS, has been inserted, and the old Section 960.3-1-4, entitled BASIS FOR SITE EVALUATIONS, has been renumbered as Section 960.3-1-5. With this format change, Section 960.3-1-5 has been revised:

(1) To remove the language that groups the postclosure technical guidelines under Subpart C into two categories of decreasing order of importance.

(2) To replace the language concerning the use of engineered barriers in site evaluations with, in essence, that proposed by the NRC staff.

(3) To remove the language dealing with technically conservative assumptions, available evidence, data limitations, and the like.

(4) To insert minor word and phrase additions for purposes of clarification of meaning and intent.

The new Section 960.3-1-4 includes general descriptions of the kinds of information and data and their sources necessary for the four principal decision points during the siting process. Reference is made in the subsection dealing with evidence for site nomination (Section 960.3-1-4-2) to the new Appendix IV to the siting guidelines; it contains a detailed list of types of information to be used in evaluating sites against the guidelines of Subparts C and D, on a guideline-by-guideline basis.

Under Section 960.3-2, SITING PROCESS, language has been included to (1) identify which guidelines would be used at different stages of the siting process and (2) to specify the type of application of such guidelines in the sense of making either a "finding" or a "determination." Reference is made to the new Appendix III, which correlates the system and technical guidelines of Subparts C and D with the principal siting decisions and the type of findings to be made at each decision point.

SUBPART B--IMPLEMENTATION GUIDELINES.

960.3 IMPLEMENTATION GUIDELINES.

The guidelines of this Subpart establish the procedure and basis for applying the postclosure and the preclosure guidelines of Subparts C and D, respectively, to evaluations of the suitability of sites for the development of repositories. As may be appropriate during the siting process, this procedure requires consideration of a variety of geohydrologic settings and rock types, regionality, and environmental impacts and consultation with affected States, affected Indian tribes, and Federal agencies.

960.3-1 SITING PROVISIONS.

The siting provisions establish the framework for the implementation of the siting process specified in Section 960.3-2. Sections 960.3-1-1 and 960.3-1-2 require that consideration be given to sites situated in different geohydrologic settings and different types of host rock, respectively. These diversity guidelines are intended to balance the process of site selection by requiring consideration of a variety of geologic conditions and media, and thereby enhance confidence in the technical suitability of sites selected for the development of repositories. As required by the Act, Section 960.3-1-3 specifies consideration of a regional distribution of repositories after recommendation of a site for development of the first repository. Section 960.3-1-4 describes the evidence that is required to support siting decisions. Section 960.3-1-5[~~4~~] establishes the bases for site evaluations [~~application~~] against the postclosure and the preclosure guidelines of Subparts C and D [~~to site evaluations~~] during the various phases of the siting process.

960.3-1-1 DIVERSITY OF GEOHYDROLOGIC SETTINGS.

Consideration shall be given to a variety of geohydrologic settings in which sites for the development of repositories may be located. To the extent practicable, sites recommended as candidate sites for characterization shall be located in different geohydrologic settings.

960.3-1-2 DIVERSITY OF ROCK TYPES.

Consideration shall be given to a variety of geologic media in which sites for the development of repositories may be located. To the extent practicable, and with due consideration of candidate sites characterized previously or approved for such characterization if the circumstances [~~so~~] apply, sites recommended as candidate sites for characterization shall have different types of host rock.

960.3-1-3 REGIONALITY.

In making site recommendations for repository development after the site for the first repository has been recommended, the Secretary shall give due

consideration to the need for, and the advantages of, a regional distribution in the siting of subsequent repositories. Such consideration shall take into account the proximity of sites to locations at which waste is generated or temporarily stored and at which other repositories have been or are being developed.

960.3-1-4 EVIDENCE FOR SITING DECISIONS.

The siting process involves a sequence of four decisions: (1) the identification of potentially acceptable sites; (2) the nomination of sites as suitable for characterization; (3) the recommendation of sites as candidate sites for site characterization; and (4), after the completion of site characterization and nongeologic data gathering, the recommendation of a candidate site for the development of a repository. Each of these decisions will be supported by the evidence specified below.

960.3-1-4-1 Site Identification as Potentially Acceptable.

The evidence for the identification of a potentially acceptable site shall be the types of information specified in Appendix IV of this Part. Such evidence will be relatively general and less detailed than that required for the nomination of a site as suitable for characterization. Because the gathering of detailed geologic data will not take place until after the recommendation of a site for characterization, the levels of information may be relatively greater for the evaluation of those guidelines in Subparts C and D that pertain to surface-identifiable factors for such site.

The sources of information shall include the literature in the public domain and the private sector, when available, and will be supplemented in some instances by surface investigations and conceptual engineering design studies conducted by the DOE. Geologic surface investigations may include the mapping of identifiable rock masses, fracture and joint characteristics, and fault zones. Other surface investigations will consider the aquatic and terrestrial ecology; water rights and uses; topography; potential offsite hazards; natural resource concentrations; national or State protected resources; existing transportation systems; meteorology and climatology; population densities, centers, and distributions; and general socioeconomic characteristics.

960.3-1-4-2 Site Nomination for Characterization.

The evidence required to support the nomination of a site as suitable for characterization shall include the types of information specified in Appendix IV of this Part and shall be contained or referenced in the environmental assessments to be prepared in accordance with the requirements of the Act. The sources of this information shall include (1) the literature and related studies in the public domain and the private sector, when available, and various meteorological, environmental, socioeconomic, and transportation studies conducted by the DOE in the affected area; (2) exploratory boreholes in the region of such site, including lithologic logging and hydrologic and geophysical testing of such boreholes, laboratory testing of core samples for

the evaluation of geochemical and engineering rock properties, and chemical analyses of water samples from such boreholes; (3) surface investigations, including geologic mapping and geophysical surveys, and compilations of satellite imagery data; (4) in situ or laboratory testing of similar rock types under expected repository conditions; (5) evaluations of natural and man-made analogs of the repository and its subsystems, such as geothermally active areas, underground excavations, and case histories of socioeconomic cycles in areas that have experienced intermittent large-scale construction and industrial activities; and (6) extrapolations of regional data to estimate site-specific characteristics and conditions. The exact types and amounts of information to be collected within the above categories, including such details as the specific types of hydrologic tests, combinations of geophysical tests, or number of exploratory boreholes, are dependent on the site-specific needs for the application of the guidelines of Subparts C and D, in accordance with the provisions of this Subpart and the application requirements set forth in Appendix III of this Part.

The evidence shall also include those technical evaluations that use the information specified above and that provide additional bases for evaluating the ability of a site to meet the qualifying conditions of the guidelines of Subparts C and D. In developing the above-mentioned bases for evaluation, as may be necessary, assumptions that approximate the characteristics or conditions considered to exist at a site, or expected to exist or occur in the future, may be used. These assumptions will be realistic but conservative enough to underestimate the potential for a site to meet the qualifying condition of a guideline; that is, the use of such assumptions should not lead to an exaggeration of the ability of a site to meet the qualifying condition.

960.3-1-4-3 Site Recommendation for Characterization.

The evidence required to support the recommendation of a site as a candidate site for characterization shall consist of the evaluations and data contained or referenced in the environmental assessment for such site, unless the Secretary certifies that such information, in the absence of additional preliminary borings or excavations, will not be adequate to satisfy applicable requirements of the Act.

960.3-1-4-4 Site Recommendation for Repository Development.

The evidence required to support the recommendation of a candidate site for the development of a repository, after the completion of characterization activities at such site, shall consist of the information specified in (1) Section 114(a) of the Act for the comprehensive statement of the basis for such recommendation and (2) Section 114(f) of the Act for the environmental impact statement. This evidence shall be obtained by the characterization of such site, according to the requirements specified in Section 113(b) of the Act and in 10 CFR Part 60.11, and by nongeologic data gathering.

960.3-1-5~~[4]~~ BASIS FOR SITE EVALUATIONS.

Evaluations of individual sites and comparisons between and among sites shall be based on the postclosure and preclosure guidelines specified in

Subparts C and D, respectively. Except for screening for potentially acceptable sites as specified in Section 960.3-2-1, such evaluations shall place PRIMARY SIGNIFICANCE on the postclosure guidelines and SECONDARY SIGNIFICANCE on the preclosure guidelines, with each set of guidelines considered collectively for such purposes.

Both the postclosure and the preclosure guidelines consist of a system guideline or guidelines and corresponding groups of technical guidelines. [~~Under the postclosure guidelines in Subpart C, the technical guidelines are separated into two groups that represent, IN DECREASING ORDER OF IMPORTANCE, (1) characteristics and processes that affect expected repository performance and (2) processes and events that could be potentially disruptive to expected repository performance.~~] The postclosure guidelines of Subpart C contain eight technical guidelines in one group. [~~Under~~] The preclosure guidelines of [~~in~~] Subpart D [~~the~~] contain eleven technical guidelines [~~are~~] separated into three groups that represent, IN DECREASING ORDER OF IMPORTANCE, (1) preclosure radiological safety; (2) environment, socioeconomics, and transportation; and (3) ease and cost of siting, construction, operation, and closure.

The relative significance of any technical guideline to its corresponding system guideline is site specific. Therefore, for each technical guideline, an evaluation of compliance with the qualifying condition [~~qualification or disqualification~~] shall be made in the context of the collection of system elements and the [~~available~~] evidence related to that guideline, considering on balance the favorable conditions and the potentially adverse conditions identified at a site. Similarly, for each system guideline, such evaluation shall be made in the context of the group of technical guidelines and the [available] evidence related to that system guideline. For purposes of recommending sites for development as repositories, such evidence shall include analyses of expected repository performance to assess the likelihood of demonstrating compliance with 40 CFR Part 191 and 10 CFR Part 60, in accordance with Section 960.4-1. [~~If the existing data for a site are not adequate to substantiate such evaluations, then an evaluation shall be based on the potential of the site to meet the qualifying condition of a guideline, using appropriate and technically conservative assumptions. That is, the DOE will use assumptions that realistically approximate the parameters or conditions considered to exist, or expected to exist or occur in the future, at such site. These assumptions will be sufficiently conservative so as to underestimate the potential for compliance with the qualifying condition of a guideline.~~] A site shall be disqualified at any time during the siting process if the evidence supports a finding [~~determination~~] by the DOE that (1) a disqualifying condition exists or (2) the qualifying condition of any system or technical guideline cannot be met.

[~~As appropriate to the postclosure guidelines of Subpart C, the above evaluations shall place primary importance on the capabilities of the natural barriers of a site for waste isolation. Considering the characteristics of and the processes operating within a geologic setting, an engineered barrier system is required by 10 CFR Part 60 to compensate for uncertainties in expected repository performance. The provisions of that regulation require that such system be designed to assure that containment of the waste will be~~

~~substantially complete during the first 300 to 1,000 years after closure and that any radionuclide release thereafter shall be a gradual process which results in small fractional releases to the geologic setting over long periods of time. Therefore, for such evaluations of a site, the use of an engineered barrier system will be considered only to the extent necessary to meet the minimum performance requirements specified in 10 CFR 60.113 and shall not be relied upon to compensate for significant deficiencies in the capabilities of the natural barriers for waste isolation.~~]

Comparisons between and among sites shall be based on the system guidelines, to the extent practicable [~~with the available evidence~~] and in accordance with the levels of relative significance specified above for the postclosure and the preclosure guidelines. Such comparisons are intended to allow comparative evaluations of sites in terms of the capabilities of the natural barriers for waste isolation and to identify innate deficiencies that could jeopardize compliance with such requirements. If the [~~available~~] evidence for the sites is not adequate to substantiate such comparisons, then the comparisons shall be based on the groups of technical guidelines under the postclosure and the preclosure guidelines, considering the levels of relative significance appropriate to the postclosure and the preclosure guidelines and the order[~~s~~] of importance appropriate to the[~~ir~~] subordinate groups within the preclosure guidelines.

Comparative site evaluations shall place primary importance on the natural barriers of the site. In such evaluations for the postclosure guidelines of Subpart C, engineered barriers shall be considered only to the extent necessary to obtain realistic source terms for site evaluations.

For a better understanding of the potential effects of engineered barriers on the overall performance of the repository system, these comparative evaluations shall consider a range of levels in the performance of the engineered barriers. That range of performance levels shall vary by at least a factor of 10 above and below the engineered-barrier performance requirements set forth in 10 CFR 60.113, and the range considered shall be identical for all sites compared. The comparisons shall assume equivalent engineered-barrier performance for all sites compared and shall be structured so that engineered barriers are not relied upon to compensate for deficiencies in the geologic media. Furthermore, engineered barriers shall not be used to (1) compensate for an inadequate site; (2) mask the innate deficiencies of a site; (3) disguise the strengths and weaknesses of a site and the overall system; and (4) mask differences between sites when they are compared.

Site comparisons performed to support the recommendation of sites for the development of repositories in Section 960.3-2-4 shall evaluate predicted releases of radionuclides to the accessible environment. For the purposes of such comparison, the accessible environment shall consist of the atmosphere, the land surface, any nearby surface water, and those portions of the lithosphere that are situated more than 10 kilometers in a horizontal direction from the outer boundary of the original location of the waste emplacement in the geologic repository. Releases of different radionuclides shall be combined by the methods specified in Appendix A of 40 CFR Part 191.

The comparisons specified above shall consist of two comparative evaluations that predict radionuclide releases for 100,000 years after

repository closure and shall be conducted as follows. First, the sites shall be compared by means of evaluations that emphasize the performance of the natural barriers at the site. Second, the sites shall be compared by means of evaluations that emphasize the performance of the total repository system. These second evaluations shall (1) consider the expected performance of the repository system; (2) be based on the expected performance of waste packages and waste forms, in compliance with the requirements of 10 CFR 60.113, and on the expected hydrologic and geochemical conditions at each site; and (3) take credit for the expected performance of all other engineered components of the repository system.

The comparison of isolation capability shall be one of the significant considerations in the recommendation of sites for the development of repositories. The first of the two comparative evaluations specified in the preceding paragraph shall take precedence unless the second comparative evaluation would lead to substantially different recommendations. In the latter case, the two comparative evaluations shall receive comparable consideration. Sites with predicted isolation capabilities that differ by less than a factor of 10, with similar uncertainties, may be assumed to provide equivalent isolation.

[~~The available evidence shall include all existing data and associated technical evaluations, including performance assessments, that provide information regarding the ability of a site to meet the qualifying conditions of any and all guidelines. The inability to perform conclusive evaluations due to limitations in the available data, models, and design information shall not be considered to be an adverse factor in comparisons between and among sites, unless those limitations are the result of site conditions so unusual or complex that appropriate assumptions regarding those conditions cannot be made.~~]

960.3-2 SITING PROCESS.

The siting process begins with site screening for the identification of potentially acceptable sites. This process was completed for purposes of the first repository before the enactment of the Act, and the identification of such sites was made after enactment in accordance with the provisions of Section 116(a) of the Act. The screening process for the identification of potentially acceptable sites[, leading to recommendations] for [sites for development of] the second and subsequent repositories[,] shall be conducted in accordance with the requirements specified in Section 960.3-2-1 of this Subpart. The nomination of any site as suitable for characterization shall follow the process specified in Section 960.3-2-2, and such nomination shall be accompanied by an environmental assessment as specified in Section 112(b)(1)(E) of the Act. The recommendation of sites as candidate sites for characterization and the recommendation of a characterized site for the development of a repository shall be accomplished in accordance with the requirements specified in Sections 960.3-2-3 and 960.3-2-4, respectively.

960.3-2-1 SITE SCREENING FOR POTENTIALLY ACCEPTABLE SITES.

[~~To identify potentially acceptable sites for development of other than the first repository, site screening activities shall systematically focus on~~

~~successively smaller and/or fewer potentially favorable land units within these larger land masses given initial consideration. The identification of such sites shall be made by the DOE through consultation with the States that contain land units under consideration and/or with Indian tribes whose land holdings or reservations contain such land units and shall involve the use of those technical guidelines in Subparts C and D considered appropriate on the basis of the available evidence. Such guidelines will be used in a manner that is consistent with the level of information available during site screening, in order to avoid any site that is perceived to have a reasonable likelihood of disqualification but which could not be formally disqualified without additional study. The siting provisions that require diversity of geohydrologic settings and rock types, as specified in Sections 960.3-1-1 and 960.3-1-2, respectively, and consideration of regionality, as specified in Section 960.3-1-3, shall be used, with due consideration of any candidate sites previously recommended and approved for characterization, to establish the range of options in site screening. Under this guidance, the land units under consideration shall be evaluated on the basis of qualifying, favorable, potentially adverse, and disqualifying conditions specified in the technical guidelines of Subparts C and D, to the extent that such conditions can be evaluated on the basis of the available evidence.]~~

To identify potentially acceptable sites for the development of other than the first repository, the process shall begin with site-screening activities that consider large land masses that contain rock formations of suitable depth, thickness, and lateral extent and have structural, hydrologic, and tectonic features favorable for waste containment and isolation. Within those large land masses, subsequent site-screening activities shall focus on successively smaller and increasingly more suitable land units.

This process shall be developed in consultation with the States that contain land units under consideration. It shall be implemented in a sequence of steps that first applies the applicable disqualifying conditions to eliminate land units on the basis of the evidence specified in Section 960.3-1-4-1 and in accordance with the application requirements set forth in Appendix III of this Part. After the disqualifying conditions have been applied, the favorable and potentially adverse conditions, as identified for each remaining land unit, shall be evaluated. The presence of favorable conditions shall favor a given land unit, while the presence of potentially adverse conditions shall penalize that land unit. Recognizing that favorable conditions and potentially adverse conditions for different technical guidelines can exist in the same land unit, the DOE shall seek to evaluate the composite favorability of each land unit. Land units that, in the aggregate, exhibit potentially adverse conditions shall be deferred in favor of land units that exhibit favorable conditions. The siting provisions that require diversity of geohydrologic settings and rock types and consideration of regionality, as specified in Sections 960.3-1-1, 960.3-1-2, and 960.3-1-1, respectively, may be used to discriminate between land units and to establish the range of options in site screening.

~~[Potentially acceptable sites will be identified during the screening process. However, if after such identification, the DOE judges that specific~~

~~sites are no longer considered potentially acceptable, then those sites may be deferred or eliminated from further consideration before site nomination.~~] To identify a site as potentially acceptable, the evidence shall support a finding that the site is not disqualified in accordance with the application requirements set forth in Appendix III of this Part and shall support the decision by the DOE to proceed with the continued investigation of the site on the basis of the favorable and potentially adverse conditions identified to date. In continuation of the screening process after such identification and before site nomination, the DOE may defer from further consideration land units or potentially acceptable sites or portions thereof on the basis of additional information or by the application of the siting provisions for diversity of geohydrologic settings, diversity of rock types, and regionality (Sections 960.3-1-1, 960.3-1-2, and 960.3-1-3, respectively). The deferral [~~and/or elimination~~] of potentially acceptable sites will be described in the environmental assessments that accompany the nomination of at least five sites as suitable for characterization.

In order to identify potentially acceptable sites for the second and subsequent repositories, the Secretary shall FIRST identify the State within which the site is located in a decision-basis document that describes the process and the considerations that led to the identification of such site and that has been issued previously in draft for review and comment by such State. SECOND, when such document is final, the Secretary shall notify the Governor and the legislature of that State and the tribal council of any affected Indian tribe of the potentially acceptable site.

960.3-2-2 NOMINATION OF SITES AS SUITABLE FOR CHARACTERIZATION.

[~~To be nominated as suitable for characterization, a site shall first have been be identified as potentially acceptable. Those potentially acceptable sites remaining at the completion of the screening process will be eligible for nomination. To proceed with the nomination process, at least~~] From the [~~five~~] sites [~~shall be~~] identified as potentially acceptable, [~~sites~~] the Secretary shall nominate [~~a suite of~~] at least five sites determined suitable for site characterization for the selection of each repository site. For the second repository, at least three of the sites shall not have been nominated previously. Any site nominated as suitable for characterization for the first repository, but not recommended as a candidate site for characterization, may not be nominated as suitable for characterization for the second repository.

The nomination of a site as suitable for characterization shall be accompanied by an environmental assessment as specified in Section 112(b)(1)(E) of the Act. Such nomination shall be based on evaluations in accordance with the guidelines of this Part, and the bases and relevant details of those evaluations and of the decision processes involved therein shall be contained in the environmental assessment for the site in the manner specified in this Subpart. The evidence required to support such evaluations and siting decisions is specified in Section 960.3-1-4-2.

960.3-2-2-1 EVALUATION OF ALL POTENTIALLY ACCEPTABLE SITES.

FIRST, in considering sites for nomination, each [~~site of the suite~~] of the potentially acceptable sites [~~for the first repository, or of any suites of potentially acceptable sites for subsequent repositories,~~] shall be evaluated on the basis of the disqualifying conditions specified in the technical guidelines of Subparts C and D, in accordance with the application requirements set forth in Appendix III of this Part. [~~To the extent practicable with the available evidence.~~] [~~To continue with the nomination process for a site.~~] This evaluation shall support a finding by the DOE that such site is not disqualified [~~on the basis of the available evidence.~~]

960.3-2-2-2 SELECTION OF SITES WITHIN GEOHYDROLOGIC SETTINGS.

SECOND, the siting provision requiring diversity of geohydrologic settings, as specified in Section 960.3-1-1, shall be applied to group all potentially acceptable sites according to their geohydrologic settings.

THIRD, for those geohydrologic settings that contain more than one potentially acceptable site, the preferred site shall be selected on the basis of a comparative evaluation of all potentially acceptable sites in that setting. This evaluation shall consider the distinguishing characteristics displayed by the potentially acceptable sites within the setting and the related guidelines from Subparts C and D. That is, the appropriate guidelines shall be selected primarily on the basis of the kinds of evidence among sites for which distinguishing characteristics can be identified. Such comparative evaluation shall be made on the basis of the qualifying conditions for those guidelines, considering, on balance, the favorable conditions and potentially adverse conditions identified at each site. Due consideration shall also be given to the siting provisions specifying the basis for site evaluations in Section 960.3-1-5[4], to the extent practicable, and diversity of rock types in Section 960.3-1-2, if the circumstances so apply.

If less than five geohydrologic settings are available for consideration, the above process shall be used to select two or more preferred sites from those settings that contain more than one potentially acceptable site, as required to obtain the number of sites to be nominated as suitable for characterization. For purposes of the second and subsequent repositories, due consideration shall also be given to the siting provision for regionality as specified in Section 960.3-1-3.

FOURTH, each preferred site within a geohydrologic setting shall be evaluated [~~on the basis of the available evidence~~] as to whether such site is suitable for the development [~~as~~] of a repository under the qualifying condition of each guideline specified in Subparts C and D that does not require site characterization (i.e., subsurface geologic, hydrologic, and geochemical data gathering) as a prerequisite for the application of such guideline. [~~The identification of each such guideline~~] The guidelines considered appropriate to this evaluation have been selected on the basis of their exclusion under [~~shall be based on~~] the definition of site characterization as specified in Section 960.2. Although the final

application of these guidelines, in accordance with the provisions set forth in Appendix III of this Part, does not require geologic data from site-characterization activities, such application will require additional data beyond those specified in Appendix IV of this Part, which will be obtained concurrently with site characterization. Such guidelines include those specified in Section 960.4-2-8-2 (Site Ownership and Control) of Subpart C; Sections 960.5-1(a)(1) and 960.5-1(a)(2) of Subpart D (preclosure system guidelines for radiological safety and environmental quality, socioeconomics, and transportation); and Section 960.5-2-1 through 960.5-2-7 of Subpart D (Population Density and Distribution, Site Ownership and Control, Meteorology, Offsite Installations and Operations, Environmental Quality, Socioeconomic Impacts, and Transportation). This evaluation shall consider on balance those favorable conditions and potentially adverse conditions identified as such at a preferred site in relation to the qualifying condition of each such guideline. For each such guideline, this evaluation shall focus on the suitability of the site for the development of a repository by considering the activities from the start of site characterization through decommissioning and shall support a finding by the DOE in accordance with the application requirements set forth in Appendix III of this Part.

FIFTH, each preferred site within a geohydrologic setting shall be evaluated [~~on the basis of the available evidence~~] as to whether such site is suitable for site characterization under the qualifying conditions of those guidelines specified in Subparts C and D that [~~are determined to~~] require [~~such~~] characterization. Such guidelines include those specified in Section 960.4-1 (a) (postclosure system guideline); Sections 960.4-2-1 through 960.2-8-1 of Subpart C (Geohydrology, Geochemistry, Rock Characteristics, Climatic Changes, Erosion, Dissolution, Tectonics, Human Interference, and Natural Resources); Section 960.5-1(a)(3) (preclosure system guideline for ease and cost of siting, construction, operation, and closure); and Sections 960.5-2-8 through 960.5-2-11 of Subpart D (Surface Characteristics, Rock Characteristics, Hydrology, and Tectonics). This evaluation shall consider on balance the favorable conditions and potentially adverse conditions identified as such at a preferred site in relation to the qualifying condition [~~and the disqualifying condition, if appropriate,~~] of each such guideline. For each such guideline, this evaluation shall focus on the suitability of the site for characterization and shall support a finding by the DOE in accordance with the application requirements set forth in Appendix III of this Part.

960.3-2-2-3 COMPARATIVE EVALUATION OF ALL SITES PROPOSED FOR NOMINATION.

SIXTH, for those potentially acceptable sites to be proposed for nomination, as determined by the process specified in Section 960.3-2-2-2, a reasonable comparative evaluation of each such site with all other such sites shall be made. For each site and for each guideline specified in Subparts C and D, the DOE shall summarize the evaluations and findings specified under Section 960.3-2-2-1 and under the fourth and fifth provisions of Section 960.3-2-2-2 [~~rationale, as appropriate to the evaluations for each such applicable guideline, that supports (a) its determinations that (1) the site is not disqualified on the basis of the available evidence and (2) the site is suitable for site characterization, and (b) its evaluation as to whether the~~

~~site is suitable for the development of a repository under each guideline that does not require site characterization as a prerequisite for application of such guideline~~]. Each such summary shall allow comparisons to be made among sites on the basis of each guideline.

960.3-2-2-4 [~~CONTENTS OF~~] THE ENVIRONMENTAL ASSESSMENT.

To document the process specified above, and in compliance with Section 112(b)(1)(E) of the Act, an environmental assessment shall be prepared for each site proposed for nomination as suitable for characterization. Each such environmental assessment shall [~~contain (1)~~] describe the decision process by which such site was proposed for nomination as described in the preceding six steps and shall contain or reference the evidence that supports such process according to the requirements of Section 960.3-1-4-2 and Appendix IV of this Part. [~~(2) the evaluations that led to the identification of the site as potentially acceptable and to the determination that such site and other such sites were not disqualified on the basis of the available evidence; (3) the basis and process for determining the geohydrologic setting in which the site is located; (4) the comparative evaluation of such site against other sites in the geohydrologic setting, including the decision process based on that evaluation which resulted in the selection of a preferred site or preferred sites in that setting; (5) the evaluation of the suitability of such site for development of a repository under each guideline specified in Subparts C and D that does not require site characterization as a prerequisite for application of such guideline; (6) the evaluation of the suitability of such site for characterization under the guidelines specified in Subparts C and D that are determined to require characterization; and, in a common chapter, (7) the comparative evaluation of such site against all other sites proposed for nomination.~~]

As [~~further~~] specified in the Act, each [~~such~~] environmental assessment shall include (1) an evaluation of the effects of the site-characterization activities at the site on public health and safety and the environment; (2) a discussion of alternative activities related to site characterization that may be taken to avoid such impacts; and (3) an assessment of the regional and local impacts of locating a repository at the site.

The draft environmental assessment for each site proposed for nomination as suitable for characterization shall be made available by the DOE for public comment after the Secretary has notified the Governor and legislature of the State in which the site is located, or the governing body of the affected Indian tribe where such site is located, as the case may be, of such impending availability.

960.3-2-2-5 FORMAL SITE NOMINATION.

After the final environmental assessments have been prepared, the Secretary shall nominate at least five sites that he determines suitable for site characterization for the selection of a repository site, and, in so doing, he shall cause to have published in the FEDERAL REGISTER a notice specifying the sites so nominated and announcing the availability of the final

environmental assessments for such sites. This determination by the Secretary shall be based on the final environmental assessments for such sites, including, in particular, consideration of the available evidence, evaluations, and the resultant findings for the guidelines of Subparts C and D so specified under the fourth and fifth provisions of Section 960.3-2-2-2. Before nominating a site, the Secretary shall notify the Governor and legislature of the State in which the site is located, or the governing body of the affected Indian tribe where such site is located, as the case may be, of such nomination and the basis for such nomination.

960.3-2-3 RECOMMENDATION OF SITES ~~[AS SUITABLE]~~ FOR CHARACTERIZATION.

After the nomination of at least five sites as suitable for site characterization for the selection of the first repository, the Secretary shall recommend in writing to the President not less than three candidate sites for such characterization. The recommendation decision shall be based on (1) the available geophysical, geologic, geochemical, and hydrologic data; (2) other information; ~~[and]~~ (3) associated evaluations and findings reported in the environmental assessments accompanying the nominations; and ~~[or]~~ (4) the considerations specified below, unless the Secretary certifies that such available data will not be adequate to satisfy applicable requirements of the Act in the absence of further preliminary borings or excavations. Such recommendation decision shall include a preliminary determination by the Secretary, referred to in Section 114(f) of the Act, that such sites are suitable for the development of repositories under the guidelines of Subparts C and D.

On the basis of the available evidence and in accordance with the siting provision specifying the basis for site evaluations in Section 960.3-1-5[4], the sites nominated as suitable for characterization shall be considered as to their order of preference as candidate sites for characterization. Subsequently, the siting provisions specifying diversity of geohydrologic settings, diversity of rock types, and, after the first repository, consideration of regionality in Sections 960.3-1-1, 960.3-1-2, and 960.3-1-3, respectively, shall be considered to determine a final order of preference for the characterization of such sites. Considering this order of preference together with the available siting alternatives specified in the Act, the sites recommended as candidate sites for characterization shall offer, on balance, the most advantageous combination of characteristics and conditions for the successful development of repositories at such sites.

The process ~~[of]~~ for the recommendation of sites as candidate sites for characterization for the selection of any subsequent repository shall be the same as that specified above for the first repository.

960.3-2-4 RECOMMENDATION OF SITES FOR THE DEVELOPMENT OF REPOSITORIES.

After completion of site characterization and nongeologic data gathering activities at ~~[not less than three]~~ the candidate sites for the development of the first repository, or from all of the characterized sites for the development of subsequent repositories, the candidate sites shall be compared

with each other on the basis of the guidelines specified in Subparts C and D. [~~according to, the siting provision specifying the basis for site evaluations in Section 960.3-1-5. After the first repository, this comparative evaluation shall include consideration of regionality, as specified under the siting provision in Section 960.3-1-3.~~] This comparison shall lead to a recommendation by the Secretary to the President of a site for the development of a repository.

Together with any recommendation to the President to approve a site for the development of a repository, the Secretary shall make available to the public, and submit to the President, a comprehensive statement of the basis of such recommendation pursuant to the requirements specified in Section 114(a)(1) of the Act, including an environmental impact statement prepared in accordance with the provisions of Sections 114(a)(1)(D) and 114(f) of the Act. The environmental impact statement shall include the results of the comparative evaluation specified above and a description of the decision process that resulted in the selection of the candidate site recommended for the development of such repository.

960.3-3 CONSULTATION.

The DOE shall provide to designated officials of the affected States and to the governing bodies of any affected Indian tribe timely and complete information regarding determinations or plans made with respect to the siting, site characterization, design, development, construction, operation, closure, decommissioning, licensing, or regulation of a repository. Written responses to written requests for information from the designated officials of affected States or affected Indian tribes will be provided within 30 days after receipt of the written requests.

In performing any study of an area for the purpose of determining the suitability of such area for the development of a repository, the DOE shall consult and cooperate with the Governor and the legislature of an affected State and the governing body of an affected Indian tribe in an effort to resolve concerns regarding public health and safety, environmental impacts, socioeconomic impacts, and technical aspects of the siting process. After notifying affected States or affected Indian tribes that potentially acceptable sites have been identified, or that a site has been approved for characterization, the DOE shall seek to enter into binding written agreements with such affected States or affected Indian tribes in accordance with the requirements of the Act.

The DOE shall also consult, as appropriate, with other Federal agencies.

960.3-4 ENVIRONMENTAL IMPACTS.

Environmental impacts shall be considered by the DOE throughout the site characterization, site selection, and repository development process. The DOE shall mitigate significant adverse environmental impacts, to the extent practicable, during site characterization and repository construction, operation, closure, and decommissioning.

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DOE REVISIONS

TO

SUBPART C--POSTCLOSURE GUIDELINES--OF THE SITING GUIDELINES OF NOVEMBER 18, 1983

SUBPART C--POSTCLOSURE GUIDELINES.

960.4 POSTCLOSURE GUIDELINES.

The guidelines in this Subpart specify the factors to be considered in evaluating and comparing sites on the basis of expected repository performance after closure. The postclosure guidelines are separated into a system guideline and eight technical guidelines. The system guideline establishes waste containment and isolation requirements that are based on NRC and EPA regulations. These requirements must be met by the repository system, which [~~consists of~~] contains natural barriers and engineered barriers. The engineered barriers will be designed to complement the natural barriers, which provide the primary means for waste isolation.

960.4-1 SYSTEM GUIDELINE.

(a) QUALIFYING CONDITION.

[~~The geologic repository shall consist of a system of multiple natural and engineered barriers that will physically separate the radioactive waste from the accessible environment after closure in accordance with the requirements set forth in 10 CFR Part 60 and 40 CFR Part 191 (see Appendix [A] I of this Part).~~]

The geologic setting at the site shall allow for the physical separation of radioactive waste from the accessible environment after closure in accordance with the requirements of 40 CFR Part 191, Subpart B, as implemented by the provisions of 10 CFR Part 60. The geologic setting at the site will allow for the use of engineered barriers to ensure compliance with the requirements of 40 CFR Part 191 and 10 CFR Part 60 (see Appendix I of this Part).

960.4-2 TECHNICAL GUIDELINES.

The technical guidelines in this Subpart set forth qualifying, favorable, potentially adverse, and, in five [~~four~~] guidelines, disqualifying conditions on the characteristics, processes, and events that may influence the performance of a repository system after closure. [~~These conditions are separated into two groups: (1) those that apply to the characteristics and processes that are expected after repository closure and that will affect the expected performance of the repository, and (2) those that apply to the processes and events that could be potentially disruptive to the expected performance of the repository. The first group includes conditions on geohydrology, geochemistry, and rock characteristics. The second group includes conditions on climatic changes, erosion, dissolution, tectonics, and human interference.~~] The [~~individual technical guidelines within each group, as well as~~] favorable conditions and the potentially adverse conditions under each guideline are NOT listed in any assumed order of importance. Potentially adverse conditions will be considered if they affect waste isolation within the controlled area even though such conditions may occur outside the controlled area.

[~~These two groups were chosen to differentiate between those characteristics of and processes operating within the geologic setting deemed likely, or expected, to affect repository performance during the first 10,000 years or more after closure, and those processes and events that, although not expected to affect repository performance after closure, must be considered because of their potential to lead to radionuclide release rates or pathways that would not be likely to occur under expected conditions. The expected characteristics and processes can be specified within the limits defined by the residual uncertainty in the data and models after site characterization, while the disruptive processes and events must be considered in terms of the likelihood of their occurrence and their potential consequences should they occur.~~]

The technical guidelines that follow establish conditions that shall be considered in determining compliance with the qualifying condition of the postclosure system guideline. For each technical guideline, an evaluation of qualification or disqualification shall be made in accordance with the requirements specified in Subpart B [~~Section 960.3-1-1~~].

[~~CHARACTERISTICS AND PROCESSES AFFECTING EXPECTED REPOSITORY PERFORMANCE~~.]

960.4-2-1 GEOHYDROLOGY.

(a) QUALIFYING CONDITION.

The present and expected geohydrologic setting of a site shall be compatible with waste containment and isolation. The geohydrologic setting, considering the characteristics of and the processes operating within the geologic setting, shall permit compliance with (1) the requirements specified in Section 960.4-1 for radionuclide releases to the accessible environment and (2) the requirements specified in 10 CFR 60.113 for radionuclide releases from the engineered-barrier system using reasonably available technology.

(b) FAVORABLE CONDITIONS.

(1) Site conditions such that the pre-waste-emplacement ground-water travel time along any path of likely radionuclide travel from the disturbed zone to the accessible environment would be more than 10,000 years.

(2) The nature and rates of hydrologic processes operating within the geologic setting during the Quaternary Period would, if continued into the future, not affect or would favorably affect the ability of the geologic repository to isolate the waste during the next 100,000 years.

(3) Sites that have stratigraphic, structural, and hydrologic features such that the geohydrologic system can be readily characterized and modeled with reasonable certainty.

[~~(4) A high effective porosity along paths of likely radionuclide travel between the host rock and the accessible environment~~.]

(4) ~~[5]~~ For disposal in the saturated zone, at least one of the following pre-waste-emplacement conditions exists:

(i) A host rock and immediately surrounding geohydrologic units with low hydraulic conductivities.

(ii) A downward or predominantly horizontal hydraulic gradient in the host rock and in the immediately surrounding geohydrologic units.

(iii) A low hydraulic gradient in and between the host rock and the immediately surrounding geohydrologic units.

(iv) High effective porosity together with low hydraulic conductivity in rock units along paths of likely radionuclide travel between the host rock and the accessible environment.

(5) ~~[6]~~ For disposal in the unsaturated zone, at least one of the following pre-waste-emplacement conditions exists:

(i) A low and nearly constant degree of saturation in the host rock and in the immediately surrounding geohydrologic units.

(ii) A water table sufficiently below the underground facility such that the capillary fringe does not encounter the host rock.

(iii) A geohydrologic unit above the host rock that would divert the downward infiltration of water beyond the limits of the emplaced waste.

(iv) A host rock that provides for free drainage.

(v) A climatic regime in which the average annual historical precipitation is a small fraction of the average annual potential evapotranspiration.

Note: The DOE will, in accordance with the general principles set forth in Section 960.1 of these regulations, revise the guidelines, as necessary, to ensure consistency with the final NRC regulations on the unsaturated zone, which were published as a proposed rule on February 16, 1984, in 49 Federal Register 5934.

~~[(7) Ground water with 10,000 parts per million or more of total dissolved solids along any path of likely radionuclide travel from the disturbed zone to the accessible environment.]~~

(c) POTENTIALLY ADVERSE CONDITIONS.

(1) Expected changes in geohydrologic conditions--such as changes in the hydraulic gradient, the hydraulic conductivity, the effective porosity, and the ground-water flux through the host rock and the surrounding geohydrologic units--sufficient to significantly increase

the transport of radionuclides to the accessible environment as compared with pre-waste-emplacement conditions.

(2) The presence of ground-water sources, suitable for crop irrigation or human consumption without treatment, along ground-water flow paths from the host rock to the accessible environment.

(3) The presence in the geologic setting of stratigraphic or structural features--such as dikes, sills, faults, shear zones, folds, dissolution effects, or brine pockets--if their presence could significantly contribute to the difficulty of characterizing or modeling the geohydrologic system.

(d) DISQUALIFYING CONDITION.

~~[A site shall be disqualified if the expected pre-waste-emplacement ground-water travel time along any path of likely radionuclide travel from the disturbed zone to the accessible environment is less than 1,000 years, unless the characteristics and conditions of the geologic setting, such as the capacity for radionuclide retardation and the ground-water flux, would limit potential radionuclide releases to the accessible environment to the extent that the requirements specified in Section 960.4-1 could be met.]~~

A site shall be disqualified if the pre-waste-emplacement ground-water travel time from the disturbed zone to the accessible environment is expected to be less than 1,000 years along any pathway of likely and significant radionuclide travel.

960.4-2-2 GEOCHEMISTRY.

(a) QUALIFYING CONDITION.

The present and expected geochemical characteristics of a site shall be compatible with waste containment and isolation. Considering the likely chemical interactions among radionuclides, the host rock, and the ground water, the characteristics of and the processes operating within the geologic setting shall permit compliance with (1) the requirements specified in Section 960.4-1 for radionuclide releases to the accessible environment and (2) the requirements specified in 10 CFR 60.113 for radionuclide releases from the engineered-barrier system using reasonably available technology.

(b) FAVORABLE CONDITIONS.

(1) The nature and rates of the geochemical processes operating within the geologic setting during the Quaternary Period would, if continued into the future, not affect or would favorably affect the ability of the geologic repository to isolate the waste during the next 100,000 years.

(2) Geochemical conditions that promote the precipitation, diffusion into the rock matrix, or sorption of radionuclides; inhibit the formation of particulates, colloids, inorganic complexes, or organic complexes that increase the mobility of radionuclides; or inhibit the transport of radionuclides by particulates, colloids, or complexes.

(3) Mineral assemblages that, when subjected to expected repository conditions, would remain unaltered or would alter to mineral assemblages with equal or increased capability to retard radionuclide transport.

(4) A combination of expected geochemical conditions and a volumetric flow rate of water in the host rock that would allow less than 0.001 percent per year of the total radionuclide inventory in the repository at 1,000 years to be dissolved.

(5) Any combination of geochemical and physical retardation processes that would decrease the [~~projected~~] predicted peak cumulative releases of radionuclides to the accessible environment by a factor of 10 as compared to those [~~projected~~] predicted on the basis of ground-water travel time without such retardation.

(c) POTENTIALLY ADVERSE CONDITIONS.

(1) Ground-water conditions in the host rock that could affect the solubility or the chemical reactivity of the engineered-barrier system to the extent that the expected repository performance could be compromised.

(2) Geochemical processes or conditions that could reduce the sorption of radionuclides or degrade the rock strength.

(3) Pre-waste-emplacement ground-water conditions in the host rock that are chemically oxidizing.

960.4-2-3 ROCK CHARACTERISTICS.

(a) QUALIFYING CONDITION.

The present and expected characteristics of the host rock and surrounding units shall be capable of accommodating the thermal, chemical, mechanical, and radiation stresses expected to be induced by repository construction, operation, and closure and by expected interactions among the waste, host rock, ground water, and engineered components. The characteristics of and the processes operating within the geologic setting shall permit compliance with (1) the requirements specified in Section 960.4-1 for radionuclide releases to the accessible environment and (2) the requirements set forth in 10 CFR 60.113 for radionuclide releases from the engineered-barrier system using reasonably available technology.

(b) FAVORABLE CONDITIONS.

(1) A host rock that is sufficiently thick and laterally extensive to allow significant flexibility in selecting the depth, configuration, and location of the underground facility to ensure isolation.

(2) A host rock with a high thermal conductivity, a low coefficient of thermal expansion, or sufficient ductility to seal fractures induced by repository construction, operation, or closure or by

interactions among the waste, host rock, ground water, and engineered components.

(c) POTENTIALLY ADVERSE CONDITIONS.

(1) Rock conditions that could require engineering measures beyond reasonably available technology for the construction, operation, and closure of the repository, if such measures are necessary to ensure waste containment or isolation.

(2) Potential for such phenomena as thermally induced fractures, the hydration or dehydration of mineral components, brine migration, or other physical, chemical, or radiation-related phenomena that could be expected to affect waste containment or isolation.

(3) A combination of geologic structure, geochemical and thermal properties, and hydrologic conditions in the host rock and surrounding units such that the heat generated by the waste could significantly decrease the isolation provided by the host rock as compared with pre-waste-emplacement conditions.

[~~POTENTIALLY DISRUPTIVE PROCESSES AND EVENTS.~~]

960.4-2-4 CLIMATIC CHANGES.

(a) QUALIFYING CONDITION.

The site shall be located where future climatic conditions will not be likely to lead to radionuclide releases greater than those allowable under the requirements specified in Section 960.4-1.

In [~~projecting~~] predicting the likely future climatic conditions at a site, the DOE will consider the global, regional, and site climatic patterns during the Quaternary Period, considering the geomorphic evidence of the climatic conditions in the geologic setting.

(b) FAVORABLE CONDITIONS.

(1) A surface-water system such that expected climatic cycles over the next 100,000 years would not adversely affect waste isolation.

(2) A geologic setting in which climatic changes have had little effect on the hydrologic system throughout the Quaternary Period.

(c) POTENTIALLY ADVERSE CONDITIONS.

(1) Evidence that the water table could rise sufficiently over the next 10,000 years to saturate the underground facility in a previously unsaturated host rock.

(2) Evidence that climatic changes over the next 10,000 years could cause perturbations in the hydraulic gradient, the hydraulic conductivity, the effective porosity, or the ground-water flux through the host rock and the surrounding geohydrologic units.

sufficient to significantly increase the transport of radionuclides to the accessible environment.

960.4-2-5 EROSION.

(a) QUALIFYING CONDITION.

The site shall allow the underground facility to be placed at a depth such that erosional processes acting upon the surface will not be likely to lead to radionuclide releases greater than those allowable under the requirements specified in Section 960.4-1.

In [~~projecting~~] predicting the likelihood of potentially disruptive erosional processes, the DOE will consider the climatic, tectonic, and geomorphic evidence of rates and patterns of erosion in the geologic setting during the Quaternary Period.

(b) FAVORABLE CONDITIONS.

(1) Site conditions that permit the emplacement of waste at a depth of at least 300 meters below the directly overlying ground surface.

(2) A geologic setting where the nature and rates of the erosional processes that have been operating during the Quaternary Period are [~~projected~~] predicted to have less than one chance in 10,000 over the next 10,000 years of leading to releases of radionuclides to the accessible environment.

(3) Site conditions such that waste exhumation would not be expected to occur during the first one million years after repository closure.

(c) POTENTIALLY ADVERSE CONDITIONS.

(1) A geologic setting that shows evidence of [~~sustained~~] extreme erosion during the Quaternary Period.

(2) A geologic setting where the nature and rates of geomorphic processes that have been operating during the Quaternary Period could, during the first 10,000 years after closure, adversely affect the ability of the geologic repository to isolate the waste.

(d) DISQUALIFYING CONDITION.

The site shall be DISQUALIFIED if site conditions do not allow all portions of the underground facility to be situated at least 200 meters below the directly overlying ground surface.

960.4-2-6 DISSOLUTION.

(a) QUALIFYING CONDITION.

The site shall be located such that any subsurface rock dissolution will not be likely to lead to radionuclide releases greater than those allowable under the requirements specified in Section 960.4-1.

In [~~projecting~~] predicting the likelihood of dissolution within the geologic setting at a site, the DOE will consider the evidence of dissolution within that setting during the Quaternary Period, including the locations and characteristics of dissolution fronts or other dissolution features, if identified.

(b) FAVORABLE CONDITION.

No evidence that the host rock within the site was subject to significant dissolution during the Quaternary Period.

(c) POTENTIALLY ADVERSE CONDITION.

Evidence of significant dissolution within the geologic setting [~~site~~]--such as breccia pipes, dissolution cavities, significant volumetric reduction of the host rock or surrounding strata, or any structural collapse--such that a hydraulic interconnection leading to a loss of waste isolation [~~between the host rock and an immediately surrounding geohydrologic unit~~] could occur.

(d) DISQUALIFYING CONDITION.

The site shall be DISQUALIFIED if it is likely that, during the first 10,000 years after closure, active dissolution [~~front will cause a hydraulic interconnection of the underground facility to the geohydrologic system of the site~~], as predicted on the basis of the geologic record, would result in a loss of waste isolation. [~~such that the requirements specified in Section 960.4-1 cannot be met~~].

960.4-2-7 TECTONICS.

(a) QUALIFYING CONDITION.

The site shall be located in a geologic setting where future tectonic processes or events will not be likely to lead to radionuclide releases greater than those allowable under the requirements specified in Section 960.4-1.

In [~~projecting~~] predicting the likelihood of potentially disruptive tectonic processes or events, the DOE will consider the structural, stratigraphic, geophysical, and seismic evidence for the nature and rates of tectonic processes and events in the geologic setting during the Quaternary Period.

(b) FAVORABLE CONDITION.

The nature and rates of igneous activity and tectonic processes (such as uplift, subsidence, faulting, or folding), if any, operating within the geologic setting during the Quaternary Period would, if continued into the future, have less than one chance in 10,000 over the first 10,000 years after closure of leading to releases of radionuclides to the accessible environment.

(c) POTENTIALLY ADVERSE CONDITIONS.

(1) Evidence of active folding, faulting, diapirism, uplift, subsidence, or other tectonic processes or igneous activity within the geologic setting during the Quaternary Period.

(2) Historical earthquakes within the geologic setting of such magnitude and intensity that, if they recurred, could affect waste containment or isolation.

(3) Indications, based on correlations of earthquakes with tectonic processes and features, that either the frequency of occurrence or the magnitude of earthquakes within the geologic setting may increase.

(4) More-frequent occurrences of earthquakes or earthquakes of higher magnitude than are representative of the region in which the geologic setting is located.

(5) Potential for natural phenomena such as landslides, subsidence, or volcanic activity of such magnitudes that they could create large-scale surface-water impoundments that could change the regional ground-water flow system.

(6) Potential for tectonic deformations--such as uplift, subsidence, folding, or faulting--that could adversely affect the regional ground-water flow system.

(d) DISQUALIFYING CONDITION.

A site shall be disqualified if, based on the geologic record during the Quaternary Period, the nature and rates of fault movement or other ground motion are expected to be such that a loss of waste isolation is likely to occur.

960.4-2-8 HUMAN INTERFERENCE.

The site shall be located such that activities by future generations at or near the site will not be likely to affect waste containment and isolation. In assessing the likelihood of such activities, the DOE will consider the estimated effectiveness of the permanent markers and records required by 10 CFR Part 60, taking into account site-specific factors, as stated in Sections 960.4-2-8-1 and 960.4-2-8-2, that could compromise their continued effectiveness.

960.4-2-8-1 NATURAL RESOURCES.

(a) QUALIFYING CONDITION.

The site shall be located such that--considering permanent markers and records and reasonable projections of value, scarcity, and technology--the natural resources, including ground water suitable for crop irrigation or human consumption without treatment, present at or near the site will not be likely to give rise to interference activities that would lead to radionuclide

releases greater than those allowable under the requirements specified in Section 960.4-1.

(b) FAVORABLE CONDITIONS.

(1) No known natural resources that have or are projected to have in the foreseeable future a value great enough to be considered a commercially extractable resource.

(2) Ground water with 10,000 parts per million or more of total dissolved solids along any path of likely radionuclide travel to the accessible environment.

(c) POTENTIALLY ADVERSE CONDITIONS.

(1) Indications that the site contains naturally occurring materials, whether or not actually identified in such form that (i) economic extraction is potentially feasible during the foreseeable future or (ii) such materials have a greater gross value, net value, or commercial potential than the average for other areas of similar size that are representative of, and located in, the geologic setting.

(2) Evidence of [~~significant~~] subsurface mining or extraction for resources within the site if it could affect waste containment or isolation.

(3) Evidence of drilling within the site for any purpose other than repository-site evaluation to a depth sufficient to affect waste containment and isolation.

(4) Evidence of a significant concentration of any naturally occurring material that is not widely available from other sources.

(5) Potential for foreseeable human activities--such as ground-water withdrawal, extensive irrigation, subsurface injection of fluids, underground pumped storage, military activities, or the construction of large-scale surface-water impoundments--that could adversely change portions of the ground-water flow system important to waste isolation.

(d) DISQUALIFYING CONDITIONS.

A site shall be disqualified if--

(1) [~~A site shall be disqualified if~~] Previous exploration, mining, or extraction activities for resources of commercial importance at the site have created significant pathways between the projected underground facility and the accessible environment; or

(2) Ongoing or likely future activities to recover presently valuable natural mineral resources outside the controlled area would be expected to lead to an inadvertent loss of waste isolation.

960.4-2-8-2 SITE OWNERSHIP AND CONTROL.

(a) QUALIFYING CONDITION.

The site shall be located on land for which the DOE can obtain, in accordance with the requirements of 10 CFR Part 60, ownership, surface and subsurface rights, and control of access that are required in order that potential surface and subsurface activities at the site will not be likely to lead to radionuclide releases greater than those allowable under the requirements specified in Section 960.4-1.

(b) FAVORABLE CONDITION.

Present ownership and control of land and all surface and subsurface rights by the DOE.

(c) POTENTIALLY ADVERSE CONDITION.

Projected land-ownership conflicts that cannot be successfully resolved through voluntary purchase-sell agreements, nondisputed agency-to-agency transfers of title, or Federal condemnation proceedings.

DOE REVISIONS

TO

SUBPART D--PRECLOSURE GUIDELINES--OF THE SITING GUIDELINES OF NOVEMBER 18, 1983

SUMMARY OF THE REVISIONS TO SUBPART D

The following is the line-in/line-out revision of Subpart D--PRECLOSURE GUIDELINES--of the DOE siting guidelines of the November 18, 1983. Additions to that version are underlined. To avoid confusion, all words, phrases, or headings that were underlined in the November 18, 1983, version have now been replaced by capital letters with underlining. Deletions are enclosed in brackets and crossed out, as for example [~~Socioeconomic parameters that~~...].

Additions include the insertion of disqualifying conditions under Section 960.5-2-4(d) (OFFSITE INSTALLATIONS AND OPERATIONS), Section 960.5-2-6(d) (SOCIOECONOMIC IMPACTS), Section 960.5-2-10(d) (HYDROLOGY), and Section 960.5-2-11(d) (TECTONICS), corresponding to "atomic energy defense activities," "proximity to water supplies and the effect upon the rights of users of water," "hydrology," and "seismic activity," respectively, of Section 112(a) of the Act. Furthermore, the disqualifier under Section 960.5-2-5(d)(3) (ENVIRONMENTAL QUALITY) has been revised to include "components of...National Forest Lands," according to Section 112(a) of the Act. Disqualifying conditions for "proximity to populations," "proximity to components of the National Park System," and "geophysics" (in the broad sense of the meaning of the term) of Section 112(a) of the Act currently exist in Section 960.5-2-1(d) (POPULATION DENSITY AND DISTRIBUTION), Section 960.5-2-5(d) (ENVIRONMENTAL QUALITY), and Section 960.5-2-9(d) (ROCK CHARACTERISTICS), respectively, of the November 18, 1983, version of the siting guidelines.

Deletions include the removal of explanatory language on types of information under the qualifying condition of Section 960.5-2-6(a) (SOCIOECONOMIC IMPACTS), because such types of information are now proposed for inclusion under Appendix D--Types of Information for the Nomination of Sites as Suitable for Characterization; and of various phrases in the qualifying condition of Section 960.5-2-5(a) (ENVIRONMENTAL QUALITY).

SUMMARY OF THE REVISIONS TO SUBPART C

Attached is the line-in/line-out revision of Subpart C--POSTCLOSURE GUIDELINES--of the DOE siting guidelines of the November 18, 1983. Additions to that version are underlined. To avoid confusion, all words, phrases, or headings that were underlined in the version of November 18, 1983, version have been replaced by capital letters with underlining. Deletions are enclosed in brackets and crossed out, as for example ~~[The geologic repository shall consist of...~~].

Additions include the insertion of disqualifying conditions in Section 960.4-2-7(d) (TECTONICS) and Section 960.4-2-8-1(d)(2) (NATURAL RESOURCES), corresponding to "geophysics" (in the broad sense of the term) and "location of valuable natural resources," respectively, of Section 112(a) of the Act. The disqualifying condition in Section 960.4-2-1(d) (GEOHYDROLOGY), corresponding to "hydrology" in Section 112(a) of the Act, has been revised to delete the exclusionary language relating to the characteristics and conditions of the geologic setting that would limit potential radionuclide releases to the accessible environment. The disqualifying condition for Section 960.4-2-6(d) (DISSOLUTION), corresponding to the broad sense of "geophysics" in Section 112(a) of the Act, has been revised to delete its connection to the system guideline of Section 960.4-1(a).

The system guideline of Section 960.4-1(a) has been revised to clarify the use of engineered barriers in a geologic repository.

A fourth favorable condition for the saturated zone has been added to Section 960.4-2-1(b)(4), as related to "high effective porosity together with low hydraulic conductivity...," and the former 960.4-2-1(b)(4) for "high effective porosity" has been deleted. Added to Section 960.4-2-1(b)(5) is a note that commits the DOE to a future revision of the guidelines to ensure consistency with the final regulations of the NRC for the unsaturated zone. Section 960.4-2-1(b)(7), dealing with "ground water with 10,000 parts per million or more of total dissolved solids," has been moved to the favorable conditions under 960.4-2-8-1(b)(2).

Deletions include the removal of (1) language that groups the postclosure guidelines under the categories of "characteristics and processes affecting expected repository performance" and "potentially disruptive processes and events"; (2) the term "sustained" from Section 960.4-2-5(c)(1); and (3) the term "significant" from Section 960.4-2-8-1(c)(2). The term "site" has been replaced by "geologic setting" in 960.4-2-6(c), and language has been added to 960.4-2 to consider potentially adverse conditions outside the controlled area if such conditions may affect waste isolation within the controlled area.

SUBPART D--PRECLOSURE GUIDELINES.

960.5 PRECLOSURE GUIDELINES.

The guidelines in this Subpart specify the factors to be considered in evaluating and comparing sites on the basis of expected repository performance before closure. The preclosure guidelines are separated into three system guidelines and eleven technical guidelines. [~~The system guidelines establish requirements that are based on applicable Federal regulations and any written agreements pursuant to the Act between the DOE and affected States and affected Indian tribes. These requirements must be met by the repository system, which includes the site and the affected surroundings, the engineered components of the repository, and the characteristics, processes, and events that may affect repository performance, considered as a system of elements acting in concert, during repository siting, construction, operation, closure, and decommissioning.~~]

960.5-1 SYSTEM GUIDELINES.

(a) QUALIFYING CONDITIONS.

[~~The system guidelines are divided into three distinct groups.~~]

(1) PRECLOSURE RADIOLOGICAL SAFETY. Any projected radiological exposures of the general public and any projected releases of radioactive materials to restricted and unrestricted areas during repository operation and closure shall meet the applicable safety requirements set forth in 10 CFR Part 20, 10 CFR Part 60, and 40 CFR 191, Subpart A (see Appendix [~~B~~] II of this Part).

[~~The system elements pertinent to this guideline are (1) the site characteristics influencing radionuclide transport through the surroundings, (2) the engineered components whose function is to control releases of radioactive materials; and (3) the people who, because of their location and distribution in unrestricted areas, may be affected by radionuclide releases.~~

[~~(2) ENVIRONMENT, SOCIOECONOMICS, AND TRANSPORTATION. To the extent practicable, the repository and its support facilities shall be sited, constructed, operated, closed, and decommissioned to (1) protect the quality of the environment in the affected area and mitigate significant adverse environmental impacts, considering technical, social, economic, and environmental factors, and (2) protect the socioeconomic welfare of the general public in the affected area. The projected risks, costs, and other impacts of waste transportation shall be considered in repository siting, and transportation operations shall be conducted in compliance with applicable Federal regulations and with those applicable State and local regulations and ordinances that are consistent with Federal regulations.~~]

(2) ENVIRONMENT, SOCIOECONOMICS, AND TRANSPORTATION. During repository siting, construction, operation, closure, and decommissioning the public and the environment shall be adequately protected from the hazards posed by the disposal of radioactive waste.

[~~The system elements pertinent to this guideline will in general consist of (1) the people who may be affected, including their lifestyles, sources of income, social and aesthetic values, and community services; (2) the air, land, water, plants, animals, and cultural resources in the areas potentially affected by such activities; (3) the transportation infrastructure; and (4) the potential mitigating measures that can be used to achieve compliance with this guideline.~~]

(3) EASE AND COST OF SITING, CONSTRUCTION, OPERATION, AND CLOSURE. [~~The technical aspects of~~] Repository siting, construction, operation, and closure shall be demonstrated to be technically feasible on the basis of reasonably available technology, and the associated costs shall be demonstrated to be reasonable relative to other available and comparable siting options.

[~~The system elements pertinent to this guideline are (1) the site characteristics that influence these activities; (2) the engineering considerations, materials, and service requirements necessary to conduct these activities; (3) written agreements between the DOE and affected States and affected Indian tribes and the Federal regulations that establish the requirements for these activities; and (4) the repository personnel at the site during construction, operation, or closure.~~]

960.5-2 TECHNICAL GUIDELINES.

The technical guidelines in this Subpart set forth qualifying, favorable, potentially adverse, and, in seven [~~three~~] guidelines, disqualifying conditions for the characteristics, processes, and events that influence the suitability of a site relative to the preclosure system guidelines. These conditions are separated into three main groups[~~, consistent with the system guidelines to which they relate~~]: (1) preclosure radiological safety; (2) environment, socioeconomics, and transportation; and (3) ease and cost of siting, construction, operation, and closure. The first group includes conditions on population density and distribution, site ownership and control, meteorology, and offsite installations and operations. The second group includes conditions related to environmental quality and socioeconomic impacts in areas potentially affected by a repository and to the transportation of waste to a repository site. The third group includes conditions on the surface characteristics of the site, the characteristics of the host rock and surrounding strata, hydrology, and tectonics. The individual technical guidelines within each group, as well as the favorable conditions and the potentially adverse conditions under each guideline, are NOT listed in any assumed order of importance.

The technical guidelines that follow establish conditions that shall be considered in determining compliance with the qualifying conditions of the preclosure system guidelines. For each technical guideline, an evaluation of qualification or disqualification shall be made in accordance with the requirements specified in Subpart B [~~Section 960.3-1-4~~].

PRECLOSURE RADIOLOGICAL SAFETY.

960.5-2-1 POPULATION DENSITY AND DISTRIBUTION.

(a) QUALIFYING CONDITION.

The site shall be located such that, during repository operation and closure, (1) the expected average radiation dose to members of the public within any highly populated area will not be likely to exceed a small fraction of the limits allowable under the requirements specified in Section 960.5-1(a)(1), and (2) the expected radiation dose to any member of the public in an unrestricted area will not be likely to exceed the limits allowable under the requirements specified in Section 960.5-1(a)(1).

(b) FAVORABLE CONDITIONS.

(1) A low population density in the general region of the site.

(2) Remoteness of the site from highly populated areas.

(c) POTENTIALLY ADVERSE CONDITIONS.

(1) High residential, seasonal, or daytime population density within the projected site boundaries.

(2) Proximity of the site to highly populated areas, or to areas having at least 1,000 individuals in an area 1 mile by 1 mile as defined by the most recent decennial count of the U.S. census.

(d) DISQUALIFYING CONDITIONS.

A site shall be DISQUALIFIED if:

(1) Any surface facility of a repository would be located in a highly populated area; or

(2) Any surface facility of a repository would be located adjacent to an area 1 mile by 1 mile having a population of not less than 1,000 individuals as enumerated by the most recent U.S. census; or

(3) The DOE could not develop an emergency preparedness program which meets the requirements specified in DOE Order 5500.3 (Reactor and Non-Reactor Facility Emergency Planning, Preparedness, and Response Program for Department of Energy Operations) and related guides or, when issued by the NRC, in 10 CFR 60, Subpart I, "Emergency Planning Criteria."

960.5-2-2 SITE OWNERSHIP AND CONTROL.

(a) QUALIFYING CONDITION.

The site shall be located on land for which the DOE can obtain, in accordance with the requirements of 10 CFR 60.121, ownership, surface and subsurface rights, and control of access that are required in order that

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surface and subsurface activities during repository operation and closure will not be likely to lead to radionuclide releases to an unrestricted area greater than those allowable under the requirements specified in Section 960.5-1(a)(1).

(b) FAVORABLE CONDITION.

Present ownership and control of land and all surface and subsurface mineral and water rights by the DOE.

(c) POTENTIALLY ADVERSE CONDITION.

Projected land-ownership conflicts that cannot be successfully resolved through voluntary purchase-sell agreements, nondisputed agency-to-agency transfers of title, or Federal condemnation proceedings.

960.5-2-3 METEOROLOGY.

(a) QUALIFYING CONDITION.

The site shall be located such that expected meteorological conditions during repository operation and closure will not be likely to lead to radionuclide releases to an unrestricted area greater than those allowable under the requirements specified in Section 960.5-1(a)(1).

(b) FAVORABLE CONDITION.

Prevailing meteorological conditions such that any radioactive releases to the atmosphere during repository operation and closure would be effectively dispersed, thereby reducing significantly the likelihood of unacceptable exposures to any member of the public in the vicinity of the repository.

(c) POTENTIALLY ADVERSE CONDITIONS.

(1) Prevailing meteorological conditions such that radioactive emissions from repository operation or closure could be preferentially transported toward localities in the vicinity of the repository with higher population densities than are the average for the region.

(2) History of extreme weather phenomena--such as hurricanes, tornadoes, severe floods, or severe and frequent winter storms--that could significantly affect repository operation or closure.

960.5-2-4 OFFSITE INSTALLATIONS AND OPERATIONS.

(a) QUALIFYING CONDITION.

The site shall be located such that present and projected effects from nearby industrial, transportation, and military installations and operations, including atomic energy defense activities, (1) will not significantly affect repository siting, construction, operation, closure, or decommissioning or can be accommodated by engineering measures and (2), when considered together with emissions from repository operation and closure, will not be likely to lead to

radionuclide releases to an unrestricted area greater than those allowable under the requirements specified in Section 960.5-1(a)(1).

(b) FAVORABLE CONDITION.

Absence of contributing radioactive releases from other nuclear installations and operations that must be considered under the requirements of 40 CFR 191, Subpart A.

(c) POTENTIALLY ADVERSE CONDITIONS.

(1) The presence of nearby potentially hazardous installations or operations that could adversely affect repository operation or closure.

(2) Presence of other nuclear installations and operations, subject to the requirements of 40 CFR Part 190 or 40 CFR 191, Subpart A, with actual or projected releases near the maximum value permissible under those standards.

(d) Disqualifying Condition.

A site shall be disqualified if atomic energy defense activities in proximity to the site are expected to conflict irreconcilably with repository siting, construction, operation, closure, or decommissioning.

ENVIRONMENT, SOCIOECONOMICS, AND TRANSPORTATION.

960.5-2-5 ENVIRONMENTAL QUALITY.

(a) QUALIFYING CONDITION.

The site shall be located such that (1) [~~the health and welfare of the public and~~] the quality of the environment in the affected area during this and future generations will be adequately protected during repository siting, construction, operation, closure, and decommissioning, and projected [~~significant adverse~~] environmental impacts in the affected area can be mitigated [~~to the extent practicable~~] to an acceptable degree, taking into account programmatic, technical, social, economic, and environmental factors; and [~~(3)~~] (2) the requirements specified in Section 960.5-1(a)(2) can be met.

(b) FAVORABLE CONDITIONS.

(1) Projected ability to meet, within time constraints, all Federal, State, and local procedural and substantive environmental requirements applicable to the site and the activities proposed to take place thereon.

(2) Potential significant adverse environmental impacts to present and future generations can be mitigated to an insignificant level through the application of reasonable measures, taking into account technical, social, economic, and environmental factors.

(c) POTENTIALLY ADVERSE CONDITIONS.

(1) Projected major conflict with applicable Federal, State, or local environmental requirements.

(2) Projected significant adverse environmental impacts that cannot be avoided or mitigated.

(3) Proximity to, or projected significant adverse environmental impacts of the repository or its support facilities on, a component of the National Park System, the National Wildlife Refuge System, the National Wild and Scenic Rivers System, the National Wilderness Preservation System, or National Forest Land.

(4) Proximity to, and projected significant adverse environmental impacts of the repository or its support facilities on, a significant State or regional protected resource area, such as a State park, a wildlife area, or a historical area.

(5) Proximity to, and projected significant adverse environmental impacts of the repository and its support facilities on, a significant Native American resource, such as a major Indian religious site, or other sites of unique cultural interest.

(6) Presence of critical habitats for threatened or endangered species that may be compromised by the repository or its support facilities.

(d) DISQUALIFYING CONDITIONS.

Any of the following conditions shall DISQUALIFY a site:

(1) During repository siting, construction, operation, closure, or decommissioning [~~would result in an unacceptable adverse impact on the health or welfare of the public or the quality of the environment, if such impact cannot be mitigated by reasonable measures,~~] the quality of the environment in the affected area could not be adequately protected or projected environmental impacts in the affected area could not be mitigated to an acceptable degree, taking into account programmatic, technical, social, economic, and environmental factors.

(2) Any part of the restricted area or repository support facilities would be located within the boundaries of a component of the National Park System, the National Wildlife Refuge System, the National Wilderness Preservation System, or the National Wild and Scenic Rivers System.

(3) The presence of the restricted area or the repository support facilities would conflict irreconcilably with the previously designated resource-preservation use of a component of the National Park System, the National Wildlife Refuge System, the National Wilderness Preservation System, [or] the National Wild and Scenic Rivers System, or National Forest Lands, or any comparably significant State protected resource that was dedicated to resource preservation at the time of the enactment of the Act.

960.5-2-6 SOCIOECONOMIC IMPACTS.

(a) QUALIFYING CONDITION.

The site shall be located such that (1) any significant adverse social and/or economic impacts induced in communities and surrounding regions by repository siting, construction, operation, closure, and decommissioning can be offset by reasonable mitigation or compensation, as determined by a process of analysis, planning, and consultation among the DOE, affected State and local government jurisdictions, and affected Indian tribes; and (2) the requirements specified in Section 960.5-1(a)(2) can be met.

~~[Socioeconomic parameters that will be considered include but are not limited to requirements for labor; impacts on the existing economic base of the affected area, including tourism, recreation, and agriculture; increases in direct and indirect employment and in business sales; competition for resources such as land, water, and construction materials; impacts on State and local community infrastructure and transportation; impacts on housing supply and demand; public-agency revenues and expenditures; impacts on lifestyle and on the quality of life; and increases in social problems, such as crime, alcoholism, and conflicts between in-migrants and long-time residents.]~~

(b) FAVORABLE CONDITIONS.

(1) Ability of an affected area to absorb the project-related population changes without significant disruptions of community services and without significant impacts on housing supply and demand.

(2) Availability of an adequate labor force in the affected area.

(3) Projected net increases in employment and business sales, improved community services, and increased government revenues in the affected area.

(4) No projected substantial disruption of primary sectors of the economy of the affected area.

(c) POTENTIALLY ADVERSE CONDITIONS.

(1) Potential for significant repository-related impacts on community services, housing supply and demand, and the finances of State and local government agencies in the affected area.

(2) Lack of an adequate labor force in the affected area.

(3) Need for repository-related purchase or acquisition of water rights, if such rights could have significant adverse impacts on the present or future development of the affected area.

(4) Potential for major disruptions of primary sectors of the economy of the affected area.

(d) Disqualifying Condition.

A site shall be disqualified if repository construction, operation, or closure would significantly degrade the quality, or significantly reduce the quantity, of water from major sources of offsite supplies presently suitable for human consumption or crop irrigation and such impacts cannot be compensated for, or mitigated by, reasonable measures.

960.5-2-7 TRANSPORTATION.

(a) QUALIFYING CONDITION.

The site shall be located such that (1) the access routes constructed from existing local highways and railroads to the site (i) will not conflict irreconcilably with the previously designated use of any resource listed in 960.5-2-5(d)(2) and (3); (ii) can be designed and constructed using reasonably available technology; (iii) will not require transportation system components to meet performance standards more stringent than those specified in the applicable DOT and NRC regulations, nor require the development of new packaging containment technology; (iv) will allow transportation operations to be conducted without causing an unacceptable [~~radiological or nonradiological~~] risk to the public [~~health and safety~~] or unacceptable environmental impacts, taking into account programmatic, technical, social, economic, and environmental factors; and (2) the requirements of Section 960.5-1(a)(2) can be met.

(b) FAVORABLE CONDITIONS.

(1) Availability of access routes from local existing highways and railroads to the site which have any of the following characteristics:

(i) Such routes are relatively short and economical to construct as compared to access routes for other comparable siting options.

(ii) Federal condemnation is not required to acquire rights-of-way for the access routes.

(iii) Cuts, fills, tunnels, or bridges are not required.

(iv) Such routes are free of sharp curves or steep grades and are not likely to be affected by landslides or rock slides.

(v) Such routes bypass local cities and towns.

(2) Proximity to local highways and railroads that provide access to regional highways and railroads and are adequate to serve the repository without significant upgrading or reconstruction.

(3) Proximity to regional highways, mainline railroads, or inland waterways that provide access to the national transportation system.

(4) Availability of a regional railroad system with a minimum number of interchange points at which train crew and equipment changes would be required.

(5) Total projected life-cycle cost and risk for transportation of all wastes designated for the repository site which are significantly lower than those for comparable siting options, considering locations of present and potential sources of waste, interim storage facilities, and other repositories.

(6) Availability of regional and local carriers--truck, rail, and water--which have the capability and are willing to handle waste shipments to the repository.

(7) Absence of legal impediment with regard to compliance with Federal regulations for the transportation of waste in or through the affected State and adjoining States.

(8) Plans, procedures, and capabilities for response to radioactive waste transportation accidents in the affected State that are completed or being developed.

(9) A regional meteorological history indicating that significant transportation disruptions would not be routine seasonal occurrences.

(c) POTENTIALLY ADVERSE CONDITIONS.

(1) Access routes to existing local highways and railroads that are expensive to construct relative to comparable siting options.

(2) Terrain between the site and existing local highways and railroads such that steep grades, sharp switchbacks, rivers, lakes, landslides, rock slides, or potential sources of hazard to incoming waste shipments will be encountered along access routes to the site.

(3) Existing local highways and railroads that could require significant reconstruction or upgrading to provide adequate routes to the regional and national transportation system.

(4) Any local condition that could cause the transportation-related costs, environmental impacts, or risk to public health and safety from waste transportation operations to be significantly greater than those projected for other comparable siting options.

EASE AND COST OF SITING, CONSTRUCTION, OPERATION, AND CLOSURE.

960.5-2-8 SURFACE CHARACTERISTICS.

(a) QUALIFYING CONDITION.

The site shall be located such that, considering the surface characteristics and conditions of the site and surrounding area, including surface-water systems and the terrain, the requirements specified in Section

960.5-1(a)(3) can be met during repository siting, construction, operation, and closure.

(b) FAVORABLE CONDITIONS.

(1) Generally flat terrain.

(2) Generally well-drained terrain.

(c) POTENTIALLY ADVERSE CONDITION.

Surface characteristics that could lead to the flooding of surface or underground facilities by the occupancy and modification of flood plains, the failure of existing or planned man-made surface-water impoundments, or the failure of engineered components of the repository.

960.5-2-9 ROCK CHARACTERISTICS.

(a) QUALIFYING CONDITION.

The site shall be located such that (1) the thickness and lateral extent and the characteristics and composition of the host rock will be suitable for accommodation of the underground facility; (2) the repository construction, operation, and closure will not cause undue hazard to personnel; and (3) the requirements specified in Section 960.5-1(a)(3) can be met.

(b) FAVORABLE CONDITIONS.

(1) A host rock that is sufficiently thick and laterally extensive to allow significant flexibility in selecting the depth, configuration, and location of the underground facility.

(2) A host rock with characteristics that would require minimal or no artificial support for underground openings to ensure safe repository construction, operation, and closure.

(c) POTENTIALLY ADVERSE CONDITIONS.

(1) A host rock that is suitable for repository construction, operation, and closure, but is so thin or laterally restricted that little flexibility is available for selecting the depth, configuration, or location of an underground facility.

(2) In situ characteristics and conditions that could require engineering measures beyond reasonably available technology in the construction of the shafts and underground facility.

(3) Geomechanical properties that could necessitate extensive maintenance of the underground openings during repository operation and closure.

(4) Potential for such phenomena as thermally induced fracturing, the hydration and dehydration of mineral components, or other physical,

chemical, or radiation-related phenomena that could lead to safety hazards or difficulty in retrieval during repository operation.

(5) Existing faults, shear zones, pressurized brine pockets, dissolution effects, or other stratigraphic or structural features that could compromise the safety of repository personnel because of water inflow or construction problems.

(d) DISQUALIFYING CONDITION.

The site shall be DISQUALIFIED if the rock characteristics are such that the activities associated with repository construction, operation, or closure are [~~projected~~] predicted to cause significant risk to the health and safety of personnel, taking into account mitigating measures that use reasonably available technology.

960.5-2-10 HYDROLOGY.

(a) QUALIFYING CONDITION.

The site shall be located such that the geohydrologic setting of the site will (1) be compatible with the activities required for repository construction, operation, and closure; (2) not compromise the intended functions of the shaft liners and seals; and (3) permit the requirements specified in Section 960.5-1(a)(3) to be met.

(b) FAVORABLE CONDITIONS.

(1) Absence of aquifers between the host rock and the land surface.

(2) Absence of surface-water systems that could potentially cause flooding of the repository.

(3) Availability of the water required for repository construction, operation, and closure.

(c) POTENTIALLY ADVERSE CONDITION.

Ground-water conditions that could require complex engineering measures that are beyond reasonably available technology for repository construction, operation, and closure.

(d) Disqualifying Condition.

A site shall be disqualified if, based on expected ground-water conditions, it is likely that engineering measures that are beyond reasonably available technology will be required for exploratory-shaft construction or for repository construction, operation, or closure.

960.5-2-11 TECTONICS.

(a) QUALIFYING CONDITION.

The site shall be located in a geologic setting in which any projected effects of expected tectonic phenomena or igneous activity on repository construction, operation, or closure will be such that the requirements specified in Section 960.5-1(a)(3) can be met.

(b) FAVORABLE CONDITION.

The nature and rates of faulting, if any, within the geologic setting are such that the magnitude and intensity of the associated seismicity are significantly less than those generally allowable for the construction and operation of nuclear facilities.

(c) POTENTIALLY ADVERSE CONDITIONS.

(1) Evidence of active faulting within the geologic setting.

(2) Historical earthquakes or past man-induced seismicity that, if either were to recur, could produce ground motion at the site in excess of reasonable design limits.

(3) Evidence, based on correlations of earthquakes with tectonic processes and features (e.g., faults) within the geologic setting, that the magnitude of earthquakes at the site during repository construction, operation, and closure may be larger than predicted from historical seismicity.

(d) Disqualifying Condition.

A site shall be disqualified if, based on the expected nature and rates of fault movement or other ground motion, it is likely that engineering measures that are beyond reasonably available technology will be required for exploratory-shaft construction or for repository construction, operation, or closure.

DOE ADDITIONS

TO

THE APPENDICES OF THE SITING GUIDELINES OF NOVEMBER 18, 1983

SUMMARY OF THE ADDITIONS TO THE APPENDICES

Minor editorial revisions have been made to Appendices I and II. Two new appendices have been added to deal with guideline application and the types of information required for nominating sites as suitable for characterization.

Appendix III, entitled APPLICATION OF THE SYSTEM AND TECHNICAL GUIDELINES DURING THE SITING PROCESS, specifies how the guidelines of Subparts C and D will be applied at the principal decision points in the siting process. Application of a guideline is interpreted in the sense of arriving at a finding of qualification or disqualification on the basis of the available evidence. The terms "application" and "finding" are defined in Section 960.2 of Subpart A, and the process of, and the available evidence for, making such applications and findings are detailed in Subpart B. Appendix III contains a table that correlates the qualifying and disqualifying conditions of the guidelines of Subparts C and D with the principal siting decisions and the type of findings made at each decision point.

Appendix IV, entitled TYPES OF INFORMATION FOR THE NOMINATION OF SITES AS SUITABLE FOR CHARACTERIZATION, lists the types of information that should be considered at the nomination stage for each technical guideline. This appendix is intended to supplement Section 960.3-1-4-2 of Subpart B, which is entitled SITE NOMINATION FOR CHARACTERIZATION and is a subsection of 960.3-1-4, AVAILABLE EVIDENCE FOR SITING DECISIONS.

APPENDIX [A] I.

NRC AND EPA REQUIREMENTS FOR POSTCLOSURE REPOSITORY PERFORMANCE.

Under proposed 40 CFR 191, Subpart B--ENVIRONMENTAL STANDARDS FOR DISPOSAL, Section 191.13, CONTAINMENT REQUIREMENTS, specifies that for 10,000 years after disposal (a) releases of radioactive materials to the accessible environment that are estimated to have more than one chance in 100 of occurring over a 10,000 year period ("reasonably foreseeable releases") shall be projected to be less than the quantities permitted by Table 2 of that regulation's Appendix; and (b) for "very unlikely releases" (i.e., those estimated to have between one chance in 100 and one chance in 10,000 of occurring over a 10,000 year period), the limits specified in Table 2 would be multiplied by 10. The basis for Table 2 is an upper limit on long term risks of 1,000 health effects over 10,000 years for a repository containing wastes generated from 100,000 metric tons of heavy metal of reactor fuel. For releases involving more than one radionuclide, the allowed release for each radionuclide is reduced to the fraction of its limit that insures that the overall limit on harm is not exceeded. Additionally, to provide confidence needed for compliance with the containment requirements specified above, Section 191.14, ASSURANCE REQUIREMENTS, specifies the disposal of radioactive waste in accordance with seven requirements, relating to prompt disposal of waste; selection and design of disposal systems to keep releases to the accessible environment as small as reasonably achievable; engineered and natural barriers; nonreliance on active institutional controls after closure; passive controls after closure; natural resource areas; and design of disposal systems to allow future recovery of wastes.

The [~~postclosure~~] guidelines [~~of Subpart C~~] will be revised as necessary after the adoption of final regulations by the EPA.

The implementation of 40 CFR 191, Subpart B is required by 10 CFR 60.112. 10 CFR 60.113 establishes minimum conditions to be met for engineered components and ground-water flow; specifically: (1) containment of radioactive waste within the waste packages will be substantially complete for a period to be determined by the NRC taking into account the factors specified in 10 CFR 60.113(b) provided that such period shall be not less than 300 years nor more than 1,000 years after permanent closure of the geologic repository; (2) the release rate of any radionuclide from the engineered barrier system following the containment period shall not exceed one part in 100,000 per year of the inventory of that radionuclide calculated to be present at 1,000 years following permanent closure, or such other fraction of the inventory as may be approved or specified by the NRC, provided that this requirement does not apply to any radionuclide which is released at a rate less than 0.1% of the calculated total release rate limit. The calculated total release rate limit shall be taken to be one part in 100,000 per year of the inventory of radioactive waste originally emplaced in the underground facility that remains after 1,000 years of radioactive decay; and (3) the geologic repository shall be located so that pre-waste-emplacement ground-water travel time along the fastest path of likely radionuclide travel from the disturbed zone to the

accessible environment shall be at least 1,000 years or such other travel time as may be approved or specified by the NRC.

The [~~postclosure~~] guidelines [~~of Subpart B~~] will be revised as necessary [~~after any substantive revisions of~~] to ensure consistency with 10 CFR Part 60. [~~by the NRC.~~]

APPENDIX [B] II.

NRC AND EPA REQUIREMENTS FOR PRECLOSURE REPOSITORY PERFORMANCE.

Under proposed 40 CFR 191, Subpart A--ENVIRONMENTAL STANDARDS FOR MANAGEMENT AND STORAGE, Section 191.03, STANDARDS FOR NORMAL OPERATIONS, specifies: (1) that operations should be conducted so as to reduce exposure to members of the public to the extent reasonably achievable, taking into account technical, social, and economic considerations; and (2) that, except for variances permitted for unusual operations under Section 191.04 as an upper limit, normal operations shall be conducted in such a manner as to provide reasonable assurance that the combined annual dose equivalent to any member of the public due to: (i) operations covered by 40 CFR Part 190, (ii) planned discharges of radioactive material to the general environment from operations covered by this Subpart, and (iii) direct radiation from these operations; shall not exceed 25 millirems to the whole body, 75 millirems to the thyroid, or 25 millirems to any other organ.

The [~~preclosure~~] guidelines [~~of Subpart B~~] will be revised as necessary after the adoption of final regulations by the EPA.

The implementation of 40 CFR 191, Subpart A and 10 CFR Part 20 is required by 10 CFR 60.111. 10 CFR 60.111 also specifies requirements for waste retrieval, if necessary, including considerations of design, backfilling, and schedule. 10 CFR Part 20 establishes (a) exposure limits for operating personnel and (b) permissible concentrations of radionuclides in uncontrolled areas for air and water. The latter are generally less restrictive than 40 CFR 191, Subpart A, but may be limiting under certain conditions (i.e., if used as a maximum for short durations rather than annual averages).

The [~~preclosure~~] guidelines [of Subpart D] will be revised as necessary [~~after any substantive revisions of~~] to ensure consistency with 10 CFR Part 60. [~~by the NRC~~.]

APPENDIX III.

APPLICATION OF THE SYSTEM AND TECHNICAL GUIDELINES DURING THE SITING PROCESS.

This appendix presents a table that specifies how the guidelines of Subparts C and D are to be applied at the principal decision points of the siting process. The decision points, as referenced in the table, are defined as follows:

"Potentially acceptable" means the decision point at which a site is identified as potentially acceptable.

"Nomination and recommendation" means the decision point at which a site is nominated as suitable for characterization or recommended as a candidate site for characterization.

"Repository site selection" means the decision point at which a site is recommended for the development of a repository.

The findings resulting from the application of a disqualifying condition for any particular guideline at a given decision point are denoted in the table by the numeral 1 or 2. The numerals 1 and 2 signify the types of findings that are required and are defined as follows:

"1" means either of the following:

(a) The available evidence does not support a finding that the site is disqualified.

or

(b) The available evidence supports a finding that the site is disqualified.

"2" means either of the following:

(a) The available evidence supports a finding that the site is not disqualified on the basis of that evidence and is not likely to be disqualified.

or

(b) The available evidence supports a finding that the site is disqualified or is likely to be disqualified.

The findings resulting from the application of a qualifying condition for any particular guideline at a given decision point are denoted in the table by the numeral 3 or 4. The numerals 3 and 4 signify the types of findings that are required and are defined as follows:

"3" means either of the following:

(a) The available evidence does not support a finding that the site is not likely to meet the qualifying condition.

or

(b) The available evidence supports a finding that the site is not likely to meet the qualifying condition, and therefore the site is disqualified.

"4" means either of the following:

(a) The available evidence supports a finding that the site meets the qualifying condition and is likely to continue to meet the qualifying condition.

or

(b) The available evidence supports a finding that the site cannot meet the qualifying condition or is unlikely to be able to meet the qualifying condition, and therefore the site is disqualified.

If performance assessments are used to substantiate any of the above findings, those assessments shall include estimates of the effects of uncertainties in data and modeling.

For both the disqualifying and qualifying conditions of any guideline, a higher finding (e.g., a "2" finding rather than "1") shall be made if there is sufficient evidence to support such a finding.

FINDINGS RESULTING FROM THE APPLICATION OF
THE QUALIFYING AND DISQUALIFYING CONDITIONS OF THE
TECHNICAL GUIDELINES AT MAJOR SITING DECISIONS

Section 960	Guideline	Condition	Siting Decision: Potentially Acceptable	Siting Decision: Nomination and Recommendation	Siting Decision: Repository Site Selection
4-1(a)	System	Qualifying	-	3	4
4-2-1(a)	Geohydrology	Qualifying	-	3	4
4-2-1(d)	Geohydrology	Disqualifying	-	1	2
4-2-2(a)	Geochemistry	Qualifying	-	3	4
4-2-3(a)	Rock Characteristics	Qualifying	-	3	4
4-2-4(a)	Climatic Changes	Qualifying	-	3	4
4-2-5(a)	Erosion	Qualifying	-	3	4
4-2-5(d)	Erosion	Disqualifying	1	1	2
4-2-6(a)	Dissolution	Qualifying	-	3	4
4-2-6(d)	Dissolution	Disqualifying	1	1	2
4-2-7(a)	Tectonics	Qualifying	-	3	4
4-2-7(d)	Tectonics	Disqualifying	1	1	2
4-2-8-1(a)	Natural Resources	Qualifying	-	3	4
4-2-8-1(d)(1)	Natural Resources	Disqualifying	1	1	2
4-2-8-1(d)(2)	Natural Resources	Disqualifying	-	1	2
4-2-8-2(a)	Site Ownership and Control	Qualifying	-	3	4
5-1(a)(1)	System	Qualifying	-	3	4
5-1(a)(2)	System	Qualifying	-	3	4
5-1(a)(3)	System	Qualifying	-	3	4
5-2-1(a)	Population Density and Distribution	Qualifying	-	3	4
5-2-1(d)(1)	Population Density and Distribution	Disqualifying	1	1	2
5-2-1(d)(2)	Population Density and Distribution	Disqualifying	1	1	2
5-2-1(d)(3)	Population Density and Distribution	Disqualifying	-	1	2
5-2-2(a)	Site Ownership and Control	Qualifying	-	3	4
5-2-3(a)	Meteorology	Qualifying	-	3	4
5-2-4(a)	Offsite Installations and Operations	Qualifying	-	3	4
5-2-4(d)	Offsite Installations and Operations	Disqualifying	1	1	2
5-2-5(a)	Environmental Quality	Qualifying	-	3	4
5-2-5(d)(1)	Environmental Quality	Disqualifying	-	1	2
5-2-5(d)(2)	Environmental Quality	Disqualifying	1	1	2
5-2-5(d)(3)	Environmental Quality	Disqualifying	1	1	2
5-2-6(a)	Socioeconomic Impacts	Qualifying	-	3	4
5-2-6(d)	Socioeconomic Impacts	Disqualifying	-	1	2
5-2-7(a)	Transportation	Qualifying	-	3	4
5-2-8(a)	Surface Characteristics	Qualifying	-	3	4
5-2-9(a)	Rock Characteristics	Qualifying	-	3	4
5-2-9(d)	Rock Characteristics	Disqualifying	-	1	2
5-2-10(a)	Hydrology	Qualifying	-	3	4
5-2-10(d)	Hydrology	Disqualifying	-	1	2
5-2-11(a)	Tectonics	Qualifying	-	3	4
5-2-11(d)	Tectonics	Disqualifying	1	1	2

APPENDIX IV

TYPES OF INFORMATION FOR THE NOMINATION OF SITES AS SUITABLE FOR CHARACTERIZATION.

The types of information specified below are those that the DOE expects will be included in the evidence used for evaluations and applications of the guidelines of Subparts C and D at the time of nomination of a site as suitable for characterization. The types of information listed under each guideline are considered to be the most significant for the evaluation of that guideline. However, the types of information listed under any particular guideline will be used, as necessary, for the evaluation of any other guideline. As stated in Section 960.3-1-4-2, the DOE will use technically conservative assumptions or extrapolations of regional data, where necessary, to supplement this information. The information specified below will be supplemented with conceptual models, as appropriate, and analyses of uncertainties in the data.

Before site-characterization studies and related nongeologic data gathering activities, the available evidence is not expected to provide precise information, but, rather, to provide a reasonable basis for assessing the merits or shortcomings of the site against the guidelines of Subparts C and D. Consequently, the types of information described below should be interpreted so as to accommodate differences among sites and differences in the information available before detailed studies.

The specific information required for the guideline applications set forth in Appendix III of this Part is expected to differ from site to site because of site-specific factors, both with regard to favorable and potentially adverse conditions and with regard to the sources and reliability of the information. The types of information specified in this appendix will be used except where the findings set forth in Appendix III of this Part can be arrived at by reasonable alternative means or the information is not required for the particular site.

960.4-2-1 Geohydrology.

Description of the geohydrologic setting of the site, in context with its geologic setting, in order to estimate the pre-waste-emplacement ground-water flow conditions. The types of information to support this description should include--

- Location and estimated hydraulic properties of aquifers, confining units, and aquitards.
- Potential areas and modes of recharge and discharge for aquifers.
- Regional potentiometric surfaces of aquifers.
- Likely flow paths from the repository to locations in the expected accessible environment, as based on regional data.

- Preliminary estimates of ground-water travel times along the likely flow paths from the repository to locations in the expected accessible environment.

- Current use of principal aquifers and State or local management plans for such use.

960.4-2-2 Geochemistry.

Description of the geochemical and hydrochemical conditions of the host rock, of the surrounding geohydrologic units, and along likely ground-water paths to locations in the expected accessible environment, in order to estimate the potential for the migration of radionuclides. The types of information to support this description should include--

- Petrology of the rocks.

- Mineralogy of the rocks and general characteristics of fracture fillings.

- Geochemical and mechanical stability of the minerals under expected repository conditions.

- General characteristics of the ground-water chemistry (e.g., reducing/oxidizing conditions and the principal ions that may affect the waste package or radionuclide behavior).

- Geochemical properties of minerals as related to radionuclide transport.

960.4-2-3 Rock Characteristics.

Description of the geologic and geomechanical characteristics of the site, in context with the geologic setting, in order to estimate the capability of the host rock and surrounding rock units to accommodate the thermal, mechanical, chemical, and radiation stresses expected to be induced by repository construction, operation, and closure and by expected interactions among the waste, host rock, ground water, and engineered components of the repository system. The types of information to support this description should include--

- Approximate geology and stratigraphy of the site, including the depth, thickness, and lateral extent of the host rock and surrounding rock units.

- Approximate structural framework of the rock units and any major discontinuities identified from core samples.

- Approximate thermal, mechanical, and thermomechanical properties of the rocks, with consideration of the effects of time, stress, temperature, dimensional scale, and any major identified structural discontinuities.

- Estimates of the magnitude and direction of in situ stress and of temperature in the host rock and surrounding rock units.

960.4-2-4 Climatic Changes.

Description of the climatic conditions of the site region, in context with global and regional patterns of climatic changes during the Quaternary Period, in order to project likely future changes in climate such that potential impacts on the repository can be estimated. The types of information to support this description should include--

- Expected climatic conditions and cycles, based on extrapolation of climates during the Quaternary Period.
- Geomorphology of the site region and evidence of changes due to climatic changes.
- Estimated effects of expected climatic cycles on the surface-water and the ground-water systems.

960.4-2-5 Erosion.

Description of the structure, stratigraphy, and geomorphology of the site, in context with the geologic setting, in order to estimate the depth of waste emplacement and the likelihood for erosional processes to uncover the waste in less than one million years. The types of information to support this description should include--

- Depth, thickness, and lateral extent of the host rock and the overlying rock units.
- Lithology of the stratigraphic units above the host rock.
- Nature and rates of geomorphic processes during the Quaternary Period.

960.4-2-6 Dissolution.

Description of the stratigraphy, structure, hydrology, and geochemistry of the site, in context with the geologic setting, to delineate the approximate limits of subsurface rock dissolution, if any. This description should include such information as the following:

- The stratigraphy of the site, including rock units largely comprised of water-soluble minerals.
- The approximate extent and configuration of features indicative of dissolution within the geologic setting.

960.4-2-7 Tectonics.

Description of the tectonic setting of the site, in context with its geologic setting, in order to project the tectonic stability of the site over the next 10,000 years and to identify tectonic features and processes that

could be reasonably expected to have a potentially adverse effect on the performance of the repository. The types of information to support this description should include--

- The tectonic history and framework of the geologic setting and the site.
- Quaternary faults in the geologic setting, including their length, displacement, and any information regarding the age of latest movement.
- Active tectonic processes, such as uplift, diapirism, tilting, subsidence, faulting, and volcanism.
- Estimate of the geothermal gradient.
- Estimate of the regional in situ stress field.
- The historical seismicity of the geologic setting.

960.4-2-8 Human Interference.

960.4-2-8-1 Natural Resources.

Description of the mineral and energy resources of the site, in order to project whether past or future exploration and recovery could have a potentially adverse effect on the performance of the repository. The types of information to support this description should include--

- Known occurrences of energy and mineral resources, including ground water.
- Estimates of the present and projected value of these resources compared with resources contained in other areas of similar size in the geologic setting.
- Past and present drilling and mining operations in the vicinity of the site.

960.4-2-8-2 Site Ownership and Control.

Description of the ownership of land for the geologic-repository operations area and the controlled area, in order to evaluate whether the DOE can obtain ownership of, and control access to, the site. The types of information to support this description should include--

- Present land ownership.

960.5-2-1 Population Density and Distribution.

Description of the population density and distribution of the site region, in order to identify highly populated areas and the nearest 1 mile by

1 mile area having a population greater than 1,000 persons. The types of information to support this description should include--

- The most-recent U.S. census, including population composition, distribution, and density.

960.5-2-2 Site Ownership and Control.

Description of current ownership of land, including surface and subsurface mineral and water rights,in order to evaluate whether the DOE can obtain control of land within the projected restricted area. The types of information to support this description should include--

- Present land ownership.

960.5-2-3 Meteorology.

The meteorological setting, as determined from the closest recording station, in order to project meteorological conditions during repository operation and closure and their potential effects on the transport of airborne emissions. The types of information to support this description should include--

- Wind and atmospheric-dispersion characteristics.
- Precipitation characteristics.
- Extreme weather phenomena.

960.5-2-4 Offsite Installations and Operations.

Description of offsite installations and operations in the vicinity of the site in order to estimate their projected effects on repository construction, operation, or closure. The types of information to support this description should include--

- Location and nature of nearby industrial, transportation, and military installations and operations, including atomic energy defense activities.

960.5-2-5 Environmental Quality.

Description of environmental conditions in order to estimate potential impacts on public health and welfare and on environmental quality. The types of information to support this description should include--

- Applicable Federal, State, and local procedural and substantive environmental requirements.
- Existing air quality and trends.
- Existing surface-water and ground-water quality and quantity.

- Existing land resources and uses.
- Existing terrestrial and aquatic vegetation and wildlife.
- Location of any identified critical habitats for threatened or endangered species.
- Existing aesthetic characteristics.
- Location of components of the National Park System, the National Wildlife Refuge System, the National Wild and Scenic Rivers System, the National Wilderness Preservation System, or National Forest Land.
- Location of significant State or regional protected resource areas, such as State parks, wildlife areas, or historical areas.
- Location of significant Native American resources such as major Indian religious sites, or other sites of unique cultural interest.

960.5-2-6 Socioeconomic Impacts.

Description of the socioeconomic conditions of the site, including population density and distribution, economics, community services and facilities, social conditions, and fiscal and government structure, in order to estimate the impacts that might result from site characterization and from the development of a repository at that site. The types of information to support this description should include--

- Population composition, density, and distribution.
- Economic base and economic activity, including major sectors of local economy.
- Employment distribution and trends by economic sector.
- Resource usage.
- Community services and infrastructure, including trends in use and current capacity utilization.
- Housing supply and demand.
- Life style and indicators of the quality of life.
- Existing social problems.
- Sources of, and trends in, local government expenditures and revenues.

960.5-2-7 Transportation.

Description of the transportation facilities in the vicinity of the site in order to evaluate existing or required access routes or improvements. The types of information to support this description should include--

- Estimates of the overall cost and risk of transporting waste to the site.

- Description of the road and rail network between the site and the nearest Interstate highways and major rail lines; also, description of the waterway system, if any.

- Analyses of the adequacy of the existing regional transportation network to handle waste shipments; the movement of supplies for repository construction, operation, and closure; removal of nonradioactive waste from the site; and the transportation of the labor force.

- Improvements anticipated to be required in the transportation network and their feasibility, cost, and environmental impacts.

- Compatibility of the required transportation network improvements with the local and regional transportation and land-use plans.

- Analysis of weather impacts on transportation.

- Analysis of emergency response requirements and capabilities related to transportation.

960.5-2-8 Surface Characteristics.

Description of the surface characteristics of the site, in order to evaluate whether repository construction, operation, and closure are feasible on the basis of site characteristics that influence those activities. The types of information to support this description should include--

- Topography of the site.

- Existing and planned surface bodies of water.

- Definition of areas of landslides and other potentially unstable slopes, poorly drained material, or materials of low bearing strength or of high liquefaction potential.

960.5-2-9 Rock Characteristics.

Description of the geologic and geomechanical characteristics of the site, in context with the geologic setting, in order to project the capability of the host rock and the surrounding rock units to provide the space required for the underground facility and safe underground openings during repository construction, operation, and closure. The types of information to support this description should include--

- Depth, thickness, and lateral extent of the host rock.

- Stratigraphic and structural features within the host rock and adjacent rock units.

- Thermal, mechanical, and thermomechanical properties and constructibility characteristics of the rocks, with consideration of the effects of time, stress, temperature, dimensional scale, and any major identified structural discontinuities.

- Fluid inclusions and gas content in the host rock.

- Estimates of the magnitude and direction of in situ stress and of temperature in the host rock.

960.5-2-10 Hydrology.

Description of the hydrology of the site, in context with its geologic setting, in order to project compatibility with repository construction, operation, and closure. The types of information to support this description should include--

- Surface-water systems, including recharge and runoff characteristics, and potential for flooding of the repository.

- Nature and location of aquifers, confining units, and aquitards.

- Potentiometric surfaces of aquifers.

- Hydraulic properties of geohydrologic units.

960.5-2-11 Tectonics.

Description of the tectonic setting of the site, in context with the regional setting, in order to estimate any expected effects of tectonic activity on repository construction, operation, or closure. The types of information to support this description should include--

- Quaternary faults.

- Active tectonic processes.

- Preliminary estimates of expected ground motion caused by the maximum potential earthquake within the geologic setting.

ONWI
Office of NuclearWaste Isolation

Project Number EAO#83-569

BATTELLE Project Management Division

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Date September 30, 1983

To Distribution

From T. Thomas/M. Balmert/J. Carr

Subject DEVELOPING RADIONUCLIDE EMISSION RATES

This memo replaces the March 8, 1983, T. Thomas memo, EAO #83-199, developing radionuclide emission rates for the environmental assessment of a repository.

Several key features of this memo need to be illuminated:

- o First, the emissions estimates are made with 6.5-year old spent fuel, while the current repository planning base documents a 10-year old spent fuel. The consequence of this is that emissions presented in this memo are somewhat higher then would be calculated from 10-year old fuel. The data in this memo is thus conservative.
- o Second, the approach of a "bounding" estimate in many instances has been adopted. The bounds are clearly identified, and should not be interpreted as expected values.
- o Lastly, the probabilities of the event are not generally important to the EA. An event is classified either as a normal operation (probability >1% per year) or an abnormal operation...one that might occur (probability $>1 \times 10^{-9}$) and therefore should be designed for, but not one whose probability is so incredibly low as to allow its dismissal.

(Continued)

To: Distribution 2 September 30, 1983
From: Thomas/Balmert/Carr EAO #83-569

Construction Radionuclide Emissions

GEIS, Volume I, Chapter 5.4.8, shows an annual estimate of radionuclides released from the mining of 30 million metric tons of salt.

Radionuclide	GEIS Annual Release Curies	EA Total Release Curies
^{220}Rn	9.3×10^{-4}	7.44×10^{-3}
^{222}Rn	1.3×10^{-3}	1.01×10^{-2}
^{210}Pb	1.1×10^{-7}	8.8×10^{-7}
^{212}Pb	1.4×10^{-6}	1.12×10^{-5}
^{214}Pb	1.3×10^{-3}	1.01×10^{-2}
^{210}Bi	1.3×10^{-3}	1.01×10^{-2}

Table 1. Construction Radionuclide Emissions
(These are slight variations of the presented numbers from the original memo.)

DOE/ET/0028, Figure 7.4.18, shows a mining period of eight years. Thus, the total RN emissions from mining 30 MMT of salt are as shown in Table 1.

These emission estimates could be ratioed to the currently planned excavation amounts, but given that current estimates for mined salt are not significantly different (25-35 MMT), that the emission estimates are coarse and that the impacts are insignificant, the values in Table 1 are proposed as bounding values.

Impacts from these releases are apparently not dependent upon the timing of the releases, so no schedule of mining needs be provided. However, the Stearn's design calls for a mining period of 28 years.

(Continued)

To: Distribution
From: Thomas/Balmert/Carr

3

September 30, 1983
EAO #83-569

CH-TRU

The most credible accident that can happen to contact-handled TRU is the puncture of the drum and subsequent release of the drum's contents. In GEIS, Table 5.4.24, it was shown that each incident would release to the atmosphere:

^{3}H	6.3×10^{-6}	Curie
^{14}C	1.6×10^{-10}	Curie
^{60}Co	6.2×10^{-13}	Curie
^{90}Sr	9.2×10^{-13}	Curie
$^{95}N6$	1.1×10^{-11}	Curie
^{106}Ru	2.8×10^{-10}	Curie

Each drum handled has a single probability of puncture of 3×10^{-5}; thus, with 202,450 drums, a total of six punctures over the facility life can be expected. This is classified as an abnormal operation.

HLW

All high level waste arriving at the repository will be vitrified in glass. The only credible accident which would release RN is a shaft drop, and clearly a shaft drop is an abnormal operation.

GEIS, Table 5.4.25, determined that an accident involving a hoist load of four canisters of 2.4 MTU* would release the quantities of radionuclides shown in Table 2. Stearns designs are for waste packages of 9.8 MTU carried one at a time on the hoist. In either case, a release scenario would be virtually identical to the original GEIS release values.

Incidentally, the release values are for commercial HLW. Defense HLW release values are substantially lower, and thus the values in Table 2 can be considered bounding for all HLW.

(Continued)

*MGDS specified 2.28 MTU

To: Distribution
From: Thomas/Balmert/Carr

September 30, 1983
EAO #83-569

^{90}Y	3.9×10^{-4}	Curies
^{90}Sr	3.9×10^{-4}	Curies
^{106}Ru	4.4×10^{-5}	Curies
^{125}Te	4.8×10^{-6}	Curies
^{134}Cs	8.0×10^{-5}	Curies
^{137}Cs	6.0×10^{-4}	Curies
^{144}Ce	2.0×10^{-5}	Curies
^{154}Ev	3.6×10^{-5}	Curies
^{238}Pu	5.6×10^{-7}	Curies
^{239}Pu	1.3×10^{-8}	Curies
^{240}Pu	5.2×10^{-8}	Curies
^{241}Pu	6.4×10^{-6}	Curies
^{241}Am	5.2×10^{-6}	Curies
^{244}Cm	4.4×10^{-5}	Curies

Table 2. Shaft Drop Release

RH-TRU

The only credible accidents that happen with the RH-TRU (some 34,365 drums) are bounded in consequences by the shaft drop. In this accident, four canisters carrying three drums each dropped down the mine shaft and burst. Some 20 percent of the material is released. The quantity of RN released to the atmosphere for such an incident is as shown in Table 3 (from GEIS, Table 5.4.25):

(Continued)

^{3}H	2.5×10^{-1}	Curies
^{14}C	$4.4 \times 10_{-4}$	Curies
^{60}Co	1.6×10^{-6}	Curies
^{63}Ni	1.6×10^{-7}	Curies
^{90}Sr	1.2×10^{-8}	Curies
^{54}Mr	8.1×10^{-8}	Curies
^{95}Nb	8.2×10^{-8}	Curies
^{137}Cs	1.9×10^{-8}	Curies
^{238}Pu	1.1×10^{-9}	Curies
^{239}Pu	7.2×10^{-11}	Curies
^{240}Pu	1.5×10^{-10}	Curies
^{241}Pu	3.6×10^{-8}	Curies
^{241}Am	1.4×10^{-10}	Curies
^{242}Cm	2.0×10^{-9}	Curies
^{244}Cm	1.4×10^{-9}	Curies

Table 3. Radionuclide Emissions From TRU Hoist Drop

The probability of occurrence was estimated in GEIS at 3.5×10^{-6}/year. This is clearly an abnormal event.

Spent Fuel

In this accident, GEIS (Table 5.4.22) determined the consequences if four spent fuel (PWR) assemblies dropped down the shaft. This is an abnormal operation.

Values reported in GEIS for radionuclide emissions are reported in Table 4.

(Continued)

To: Distribution 6 September 30, 1983
From: Thomas/Balmert/Carr EAO #83-569

The Stearn's design calls for 6 PWR assembles to be on a hoist. For hoist failure releases, therefore, the values reported in Table 4 must be multiplied by 1.5 for the purposes of the current EA Analysis.

	GEIS		EA Release
^{3}H	6	Curies	9
^{14}C	4×10^{-2}	Curies	6×10^{-2}
^{85}Kr	$4 \times 10^{+3}$	Curies	$6 \times 10^{+3}$
^{90}Sr	1×10^{-4}	Curies	1.5×10^{-4}
^{90}Y	1×10^{-4}	Curies	1.5×10^{-4}
^{129}I	6×10^{-3}	Curies	9×10^{-3}
^{137}Cs	1.5×10^{-4}	Curies	2.25×10^{-4}
^{238}Pu	4×10^{-6}	Curies	6×10^{-6}
^{239}Pu	5.8×10^{-7}	Curies	8.7×10^{-7}
^{240}Pu	9×10^{-7}	Curies	1.35×10^{-6}
^{214}Pu	1.4×10^{-4}	Curies	2.1×10^{-4}
^{241}Am	$3.2 \times 1-^{-6}$	Curies	4.8×10^{-6}
^{244}Cm	1.8×10^{-6}	Curies	2.7×10^{-6}

Table 4. Spent Fuel Shaft Drop

Spent Fuel Handling Accident

In this accident, the 12 PWR assemblies in a railcar cask are somehow damaged within the receiving building. Because of filtration, vitually all of the particulate is contained. However, the gases are not totally filtered. This is an incident chosen to involve the greatest number of assemblies which could be affected by a single cause event.

It is assumed that 30 percent of the void gases in the pins would be released by the accident. Gaseous releases, then, can be found by multiplying the Table 3 GEIS values by "3" (to account for 12 assemblies instead of 4) and by "0.3" (to account for release fraction).

(Continued)

APPENDIX B

DEVELOPING RADIONUCLIDE EMISSION RATES

(SEPTEMBER 30, 1983)

MEMO FROM T. THOMAS, M. BALMERT, AND J. CARR

OFFICE OF NUCLEAR WASTE ISOLATION

To: Distribution
From: Thomas/Balmert/Carr

September 30, 1983
EAO #83-569

Results show the following release amounts:

^{3}H	5.4	Curies
^{14}C	3.6×10^{-2}	Curies
^{85}Kr	$3.6 \times 10^{+3}$	Curies
^{129}I	5.4×10^{-3}	Curies

This is an abnormal condition.

Spent Fuel - Void Gases Release into Transportation Cask

The most complete set of pin failure statistics were collected at Savanah River Plant and reported in DOE/ET/0054, page V-16. There, it is reported that 1,200 casks containing 25 assemblies each were transported without failure. The number of pins shipped, although unreported, had to be at least 1.9 million (or an 8x8 array) and could have been as many as 7.9 million (on a 17x17 array).

Using these numbers, and standard statistical techniques for estimating upper confidence bounds of the binomial distribution parameter, it can be shown that the 95 percent upper confidence bound for the pin failure rate is between 0.4 and 2 per million (depending upon the number of pins assumed in the preceding paragraph).

MGDS reports that there will be 765,000 pins shipped per year. I rounded this upward to 1 million pins per year for the following analysis.

Given a failure rate of 2 pins per million, then in a given year (1 million pins) one can expect to see 0, 1, 2, 3, 4 or even more failures: the average number, averaged over the years, is two. Using the binomial distribution, it can be shown that 99 years out of 100, there will be no more than 6 pin failures in a single year.

GEIS reports the following values for a pin failure release (Table 7.4.11 of DOE/ET/0028). These are multiplied by 6 to obtain the bounding EA estimate.

Radionuclide	GEIS	EA RELEASE VALUE (Bounding)
^{3}H	5×10^{-3} Curies	3×10^{-2} Curies
^{14}C	4×10^{-5} Curies	2.4×10^{-4} Curies
^{85}Kr	3 Curies	18 Curies
^{129}I	5×10^{-6} Curies	3×10^{-5} Curies

Because leakers can normally (but infrequently) be expected, this is an expected operating condition.

TJT:MEB:JAC/cjc

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